LECTURES

ON THE

PRESERVATION OF HEALTH.

BY

CHARLES A. CAMERON, PH.D., M.D.,

LICENTIATE OF THE KING AND QUEEN'S COLLEGE OF PHYSICIANS; PROFESSOR OF HYGIENE, OR POLITICAL MEDICINE, IN THE ROYAL COLLEGE OF SURGEONS IN IRELAND; PROFESSOR OF CHEMISTRY AND NATURAL PHILOSOPHY IN STEEVENS' HOSPITAL AND MEDICAL COLLEGE; LECTURER ON CHEMISTRY IN THE LEDWICH SCHOOL OF MEDICINE; ANALYST TO THE CITY OF DUBLIN; ETC., ETC., ETC.

ILLUSTRATED WITH WOOD CUTS.

LONDON AND NEW YORK:
CASSELL, PETTER, AND GALPIN.
1868.

PRINTED AT THE STEAM-PRESS OF PURDON, BROTHERS,
23, BACHELOR'S-WALK, DUBLIN.

TO

BARON VON LIEBIG,

WHOSE WRITINGS FIRST INSPIRED ME WITH A

LOVE FOR SCIENCE,

AND WHOSE COMMENDATION

IT HAS BEEN MY GOOD FORTUNE TO OBTAIN,

I DEDICATE, BY PERMISSION,

THIS LITTLE WORK.

PREFACE.

The following pages contain a condensed report of a course of Twelve Lectures on Public Health, which I delivered in the Royal College of Surgeons during the summer of the present year.

They are now published at the request of the Municipal Corporation of Dublin, who conceive that their circulation might aid in the wider diffusion of a knowledge of the laws of health, and thereby supplement the good work of sanitary reform, in which the "Public Health Committee" of the Municipality are now so successfully engaged.

Dublin, 102, Lower Baggot-street,
August, 1868.

TABLE OF CONTENTS.

LECTURES ON HEALTH.

LECTURE I.—ON POLITICAL MEDICINE AND PUBLIC HEALTH.

MR. PRESIDENT, LADIES, AND GENTLEMEN,—I avail myself of this opportune occasion—the first afforded to me—to thank the Royal College of Surgeons in Ireland for the honor which they have conferred upon me in placing me in the position which I occupy this day. The Professor of Hygiene, or Political Medicine, in this Institution is, in one respect, differently circumstanced from his colleagues; for, whilst their lectures are confined to strictly professional audiences, his discourses are addressed to both the medical and non-medical sections of the public. The prominence thus given to the professorial chair in which the electors of this College have so kindly placed me cannot fail to act as a powerful stimulus to the efficient performance of the duties which devolve upon my office. I see around me many members of the medical profession who are distinguished for their achievements in the noble sphere of labor in which they are engaged; there are present a large number of young men who are studying to acquire that knowledge which will enable them hereafter to alleviate human suffering in disease; and it is a pleasure to me to perceive that so large a proportion of the audience whom I have the honor to address is composed of non-medical persons—ladies as well as gentlemen.

It is somewhat embarrassing to lecture on technical subjects before an auditory so peculiarly constituted, because those topics which might prove novelties to the layman would seem trite and worn to the practitioner, and perhaps even to the student, of medicine. Feeling assured, however, that my professional brethren merely compliment me by their presence, and are too well informed relative to sanitary matters to require enlightment from me, and knowing also that medical students do not usually receive special instruction in hygiene, I think I shall make my observations most useful by directing them more particularly to the non-professional persons whose attention I may succeed in obtaining.

The courses of lectures on public health hitherto delivered in this institution have always been more or less of a popular character; and my immediate and distinguished predecessor, Doctor Mapother, has, by his admirable addresses in this theatre, done much to enlighten the public mind on all the more important subjects relating to the health of the community. I do not venture to hope that my lectures on public health will prove one-half so attractive or so useful as have those which Doctor Mapother has delivered here; I shall, however, earnestly endeavour to follow the excellent example which he has afforded his successors, and so far as my powers admit render the lectures on public health delivered by me in the Royal College of Surgeons not altogether unworthy of the high scientific character of this institution.

Political medicine, strictly speaking, concerns itself but little relative to the cure of disease; the problem which it seeks to solve is, how disease may be averted. The results of the investigations of the pathologist and the physiologist establish more or less accurately the nature of a malady, and suggest the appropriate treatment. The cultivator of political medicine, applying the knowledge acquired by the labors of the phy-

siologist and the pathologist to his own purpose, endeavours to remove the cause or causes which produced the disease. Those who devote themselves to the study of public hygiene require, therefore, a more extended knowledge of science than the mere physician or surgeon, who occupies himself solely with the curative treatment of disease. Sanitary science is made up of many branches of knowledge, and the great questions relating to the public health can only be successfully answered by those who combine in themselves the knowledge—more or less profound—of the physician, the chemist, the physicist, the botanist, and the geologist. There are thousands of medical men who, though capable of skilfully treating all the commonly occurring diseases, do not understand the use of the microscope, could not perform the simplest chemical analysis, nor properly explain the principles of ventilation. There is much wanted a class of highly-educated medical men who would wholly devote themselves to sanitary science. Physicians who are so fortunate as to have numerous patients cannot, as a general rule, spare time for purely scientific pursuits not directly affecting their practice; and it requires no argument to prove that very few active practitioners could successfully study such subjects, as, for example, the water supply and sewerage of towns, the heating and ventilation of dwellings, epizoötics dangerous to man, and epiphytic outbreaks—all of which relate to the public health. There is a wide field for the labors of the professors of preventive medicine. A large proportion of the deaths which daily occur in these countries is due to diseases which hygienic means, vigorously employed, are capable of extirpating. Small-pox, some years ago, annually carried off several thousand persons in Ireland alone; but, owing to the rigorous enforcement of that infallible preventive—vaccination—this loathsome disease has literally been "stamped out" in this island, though still permitted to ravage the sister countries. What has been

done in respect to small-pox might be accomplished, though perhaps not so easily, in the case of all other infectious and contagious diseases. There is sufficient evidence to justify the belief that fever, cholera, whooping-cough, and, in a word, all infectious and contagious diseases, are produced by the introduction of an animal poison into the body—each variety of poison producing a different disease. These poisons are as much entities as are arsenic or strychnine; and as they possess in all probability an organized structure, they are capable of reproducing themselves under favorable conditions—that is, when located in the human body. On the other hand, it is nearly certain that these poisons cannot long exist in air, water, or earth. If these statements rest upon a foundation of truth, as I believe they do, then you can easily perceive how important are the problems of preventive medicine. The nature of the virus of each infectious or contagious disease has to be exhaustively investigated, and the conditions under which it is developed have to be discovered. These points ascertained, it is comparatively easy to suggest efficacious measures for the prevention of the disease; and these measures might then come within the domain of State, or political medicine, and have to be enforced just in the same way that vaccination is now rendered compulsory.

The effective administration of sanitary laws and the discovery of the facts upon which they are based involve a liberal pecuniary expenditure. Until very recently the money required to carry on investigations relative to the public health was doled out in miserably small sums by the State. At present more enlarged and liberal ideas relative to sanitary matters prevail amongst the governing classes; and the existence of a Public Health Department of the Privy Council is a kind of recognition that the health of the British people is a matter worthy of the attention of our rulers. It is, how-

ever, a patent fact that the sum of money annually devoted to the purpose of improving the public health is utterly inadequate. No doubt, the burden of effecting most kinds of sanitary reforms devolves naturally upon the municipal and other local authorities; but these bodies should be guided, occasionally assisted, and, perhaps, sometimes forced into action by a great central sanitary organization, provided with ample pecuniary resources. It is but yesterday that a hostile force left this empire on, perhaps, the noblest mission ever entrusted to an invading army. The British people cheerfully pay five millions of pounds to accomplish the delivery of a few of their countrymen from the dismal dungeons of the barbarous monarch of Abyssinia. Such a national act as this is, prompted by the purest motives, free from the slightest stain of ambition, avarice, or even the love of glory, will constitute the brightest chapter in the history of the British people. When we find the tax-payers of these countries contributing so liberally and so freely to the realization of an object so purely philanthropic as the preservation of King Theodore's captives from impending death, there is good reason to believe that they would not hesitate to grant ample means for the purpose of saving the thousands of lives annually menaced by crueller despots than the grim Theodore—by fevers, small-pox, cholera. He who vanquishes these deadly enemies of man achieves a victory far more glorious than ever warrior won. Triumphs over these foes are not followed by the wail of the widow or the cry of the fatherless. The sole fruits of the conquest are long life, health, and happiness; and surely these are trophies worthy of a nation's ambition!

The largest portion of the revenue of the country is devoted to the maintenance of our army and navy, designed to preserve to us our lives and liberty. This is a wise precaution; but are there not other enemies than our fellow-men, whose power we should

always be prepared to resist? During the fiercest wars waged by Great Britain, the deaths of her soldiers and sailors in actual combat were never a tithe of the number of her civil population slain by preventible diseases. In London alone, small-pox killed, last year, more people than the British army lost at the battle of the Alma; and zymotic diseases annually carry off in the same city more lives than were lost by our army at the battle of Waterloo. I think I have said sufficient to convince even the most sceptical that the people of these islands require an army of sanitarians to protect them from the ravages of diseases which naturally have no abiding place amongst them; and I trust that at no remote period a fair proportion of the public funds will be devoted to the paramount object of promoting every measure tending to improve the health and increase the longevity of the community.

Hygiene is the science which relates to the physical condition of man, and to the means by which his health may be sustained, and his life prolonged to old age. Many of the laws of this science were known to the ancients. Asclepiades was aware of the advantages resulting from the use of wholesome food, good water, and pure air, and insisted that dietetic means were the most important in promoting health. Herodicus, five centuries before the Christian era, employed gymnastic exercise in the treatment of disease, and as a means of preserving the health. Many of Hippocrates' medical aphorisms refer to the means by which the body may be invigorated, and life prolonged. Pythagoras wrote much on sanitary subjects, and often with great acumen. Amongst the Greeks, the first code of State sanitary laws was that propounded by Lycurgus, which, severe, and even cruel, as it undoubtedly was, powerfully contributed to produce a race of vigorous, healthy, well-formed men. The sanitary observances of the Athenians, less severe than those practised by their

sterner Spartan neighbours, yet served to preserve the physical condition of their bodies, without retarding the development of their intellectual faculties. That the laws of public health observed by the classic Greeks were admirably adapted to promote the beauty of the human form, the exquisite marbles of Phidias and Praxiteles, of Scopas and Agasias, testify even at the present day.

The Romans contributed but little to the science of medicine; but they must at least have had a good practical acquaintance with military hygiene, for, even in modern times, the sanitary condition of armies in the field was inferior to that of the Roman legions during campaigns.

The Jews have long enjoyed the inestimable advantages of a code of sanitary laws derived from a divine source, and implicitly observed for a period of 3400 years by the great majority of that people. The Jews have always suffered less than Christians during epidemics; and the comparative immunity of this "peculiar people" from contagious and infectious diseases is evidently due to their habits of personal cleanliness, so imperatively enjoined by their religion.

During the middle ages very little attention was given to the subject of public health. The houses of the middle and lower classes were small, and the rooms incommodious, dark, and ill ventilated. The towns and cities were mostly enclosed within high walls; there were no sewers; the streets were unpaved and unlighted; the water supplies were often impure; and the dead were interred within the town. No hospitals existed for the relief of the sick, and every house in which a patient suffering from an infectious malady lay became a focus from which the disease spread. These were, as a general rule, the conditions under which the denizens of European towns existed during that long and dreary period which so truly has been termed the dark ages.

The disregard paid to the most obvious rules of health by the inhabitants of medieval cities produced a frightful mortality, which occasionlly culminated to a point which threatened the extinction of populous communities. The average duration of human life did not exceed 20 years, and in some very unhealthy towns it was not more than 18 years. At a later period, when great strides in civilization took place, London was still, with respect to sanitary matters, very much in the same condition, or, perhaps, worse than in the darkest period of the middle ages. Between the years 1629 and 1635 five persons in every hundred died annually in London. From 1660 to 1679—a period in which the frightful "plague" ravaged the city—the annual death rate was 8 per cent. From 1728 to 1780 the average number of deaths per hundred living was five, showing the mean duration of human life to have been only 20 years. At the present time London is the healthiest of the large cities of the United Kingdom, its death rate being less than 23 per 1,000 living; and I think I shall be able to show that this remarkable amelioration in the health of its inhabitants, as compared with the last century, is solely due to the vast sanitary improvements which have been effected within the last fifty years.

I have stated that during the middle ages—indeed, I might have said until the eighteenth century—disease occasionally threatened to extirpate whole communities. In the fourteenth century a dreadful epidemic swept over Europe, destroying millions of persons, and creating universal consternation. It was known by the terrific term, *black death*, and few affected by it recovered. It was a highly inflammatory malady, the more prominent symptoms being eruptions of painful boils, expectoration of blood, inflammation of the lungs, bleeding at the nose, and black or blue patches on portions of the body, more especially the tongue and fauces. Sometimes the patient fell into a profound sleep, from

which there was no awakening in this world; at other times there was continued sleeplessness during the whole course of the disease. This malady appears to have been beyond the reach of medical skill. It spread to the lower animals, of which immense numbers perished, more especially in the South of Europe. There is evidence to show that the black death originated in Asia—most probably in China—and gradually spreading westward, entered Europe, where, owing to the insanitary condition of the towns, the virus of the disease found a congenial, fructifying soil. It has been contended that the black death probably originated sporadically in Europe, owing to the filthy habits of the people; but I think it is most likely that the germ of the disease came in the first instance from the East—that fountain head of pestilential streams.

The history of nations is but little more than the biographies of monarchs. The annals of our country are ample on all subjects of a political character; but the inner life of the people, their habits and customs, their social condition and peculiarities, are topics which the historian touches lightly upon, or leaves unnoticed. The frightful pestilences which desolated the west of Europe in the fourteenth century are either not mentioned in the popular histories of France and England, or if alluded to, the space devoted to the description of those events, of such momentous interest to man, is less than that occupied in describing the personal appearance of a king or the details of a petty battle. Imagination fails to realize the extent of misery caused by the epidemics of the fourteenth century. In the great outbreak to which I have just alluded, it has been estimated that nearly 40,000,000 people perished in the east alone. In Germany, where the disease was least virulent, more than 1,200,000 fell victims to it. In Italy the mortality was frightful—Venice lost 100,000 of her citizens, Sienna, 70,000, and Florence, 50,000. In London the

disease raged with great violence, 50,000 persons having been interred in one burial place. Throughout the whole country it is certain that more persons fell victims to the disease than were spared by it; for, according to one statement, but evidently an exaggerated one, not a tenth of the inhabitants were left alive. It has been stated that the black death carried off, at the most moderate computation, a fourth part of the inhabitants of Europe, or about 25,000,000 of souls.

I have alluded to the dreadful epidemics of the middle ages in order to show the great saving of life which has resulted from the improvement of the sanitary conditions of towns, and also from the more general habits of personal cleanliness which distinguish the modern Europeans from their medieval ancestors. I also wish to direct attention to those almost forgotten calamities, because they are calculated to teach us important lessons. Are we sure that we are safe from another visitation of the black death? There are epidemologists who believe that the germs of this disease still linger amongst the deep valleys of the Himalayas, and that they may yet be wafted to Europe. If such an event should ever unfortunately take place, I fear that in some of our towns the virus of the disease would find a genial soil; but the general sanitary state of Europe renders unlikely the recurrence of the painful scenes of the fourteenth century. We know the means by which all such diseases may be successfully resisted, and it is to a great extent our own fault that even the Asiatic cholera is still allowed to force its way periodically into these countries. It was early discovered that these epidemic diseases were contagious, or, to use a popular expression, catching; and shortly after the first great outbreak of the black death, precautions were adopted in Italy for the purpose of isolating persons suffering from contagious disease. The earliest regulations for this purpose were issued on the 17th January, 1374, by the ruler of Reggio, the

Viscount Bernabo, and they appear to have successfully accomplished his object. Bernabo's regulations, and those of his successor, were based on principles, the soundness of which is surprising, when we consider the darkness of the age in which they were framed. The patients were removed to the open field, and those in attendance upon them were not allowed to come in contact with healthy persons. Every consumable substance which had been in contact with the sick was committed to the flames. The houses of the affected were disinfected; and persons coming from places in which the disease existed were rigorously refused admission. Bernabo's regulations were, with various modifications, followed by the various States of Italy. In 1485 the first lazarettos, or quarantine houses, were established; and about 40 years later "bills of health" were issued to ship masters, stating whether or not the port from which they sailed was the seat of disease.

Since the sixteenth century the progress of sanitary legislation has been slow; but within the last few years increased attention has been given to the important subject of public health, and the prospects of great improvements being effected in it are brighter than they have ever been. The causes of epidemological diseases are now being thoroughly investigated. Local authorities are improving the hygienic condition of towns; and the legislature has taken active measures to prevent the pollution of our rivers and atmosphere. Most large towns are now provided with officers of health, and the valuable results which invariably attend the labors of this useful class of public servants have been irrefutably proved. It is a fact worth noticing that last year the most healthy of the thirteen largest towns in the United Kingdom was London, which was the first to be provided with officers of health, and the least healthy was Manchester, which had no officers of health until the present year.

Death Rates in 1867.

Manchester	...	... 31.40	in the 1000 living.
Newcastle-on-Tyne		... 30.79	"
Liverpool	...	... 29.57	"
Glasgow	...	... 28.54	"
Salford	...	... 28.50	"
Edinburgh	...	... 27.13	"
Dublin	...	... 27.06	"
Leeds	...	... 26.96	"
Hull	...	... 24.93	"
Sheffield	...	... 24.67	"
Birmingham	...	... 24.27	"
Bristol	...	... 23.08	"
London	...	... 22.98	"

In Dublin we have an able officer of health, Dr. Mapother. He was appointed in the year 1864, and since that period the sanitary condition of our city has been greatly improved. To his labors, and to those of the Public Health Committee of the Corporation, I hope to do full justice in a future lecture.

LECTURE II.—ON WATER.

Few sanitary subjects have during late years attracted more attention than that relating to potable waters. During epidemics—such, for example, as cholera—the virus of the disease is often directly introduced into the body by means of water; and the use of impure kinds of this fluid, though they may not actually contain the contagious matter of the disease, yet, by inducing attacks of other maladies, often predisposes persons to contract the more serious epidemic disease.

Pure water is composed of the two elementary, or simple bodies, named oxygen and hydrogen. It is colorless and transparent, and has neither flavor nor odor. In this pure condition, however, water is never met with in nature, and even if it were, it would not be a pleasant beverage. Indeed, some authorities believe that pure, or distilled water is indigestible.

Water is a constituent—often a very abundant one—of most substances, mineral, vegetable, and animal. Wheat flour contains 13 per cent.; potatoes, 75 per cent.; and some kinds of turnips, 94 per cent. of water. In every four pounds weight of lean beef or mutton there are three pounds weight of water, which may be driven off by simple drying. The largest portion of the matter introduced into our stomachs is composed of water; and a man weighing 14 stones, if dried at a temperature of 212 degs. Fahrenheit, would lose nearly 10 stones of his weight. The mobility of the body is chiefly due to the large amount of water contained in it, and if the supplies of this essential fluid were cut off, death of the most painful kind speedily ensues.

The ocean is the indirect source of all the water of

our rivers and springs. The heat of the sun's rays is continuously distilling the water from the ocean's surface, and converting it into an invisible vapor, or gas. The air holds this vapor, or steam, in solution just in the same way that sugar is dissolved in water, and the warmer the air is, the greater is the quantity of watery vapor which it is capable of holding in solution. There are continual currents in the atmosphere, and the air which to-day overlies the ocean may to-morrow be a hundred miles from the sea. When the temperature of air saturated with watery vapor becomes lowered, then its capacity for holding water in solution being diminished, a portion of that substance is condensed and assumes some liquid or solid form, such as rain, snow, ice, or dew. Mountain tops cool the air, and hence much of the rain that falls descends in the uplands. Of the water derived from this atmospheric source, a small proportion evaporates into the air, and the remainder gradually drains into the ocean, from which, in the progress of time, it will be again converted into vapor. On its way to the sea it gathers itself together, so to speak, and forms rivers. The smallest springs and the largest rivers are produced from drainage water, and wells are made by digging deep into the earth, in order to intercept a portion of the underground drainage water ere it reaches a river.

Our water supplies being directly derived from drainage, it follows that the nature of the rock or soil from which this indispensable fluid is collected exercises some influence upon its composition. In soils there are a great many substances which water—more especially when holding carbonic acid gas in solution—is capable of dissolving. These substances are used as food by plants, and although they are so soluble in water *out* of the soil, there is a beautiful provision of nature which prevents the drainage water from removing them, except in small quantities, from the soil; for otherwise the most fertile land would speedily be deprived of its plant-food

and be rendered barren. Drainage water, however, always contains some solid matters dissolved in it, and their amount chiefly depends, as I have stated, upon the nature of the rocks which form the drainage area, or *catchment* basin, as the district yielding the water is termed. The *primitive* or oldest rocks—granite, gneiss, trap, porphyry, clay slate, afford, with few exceptions, very pure water. The millstone grit yields also very good water, but generally somewhat harder than that obtained from the granite and gneiss. In general, the lias, limestone, and chalk yield water not equal in purity to that obtained from the granitic rocks, but having a much pleasanter flavor, owing to the large quantity of carbonic acid gas which it holds in solution. This water is usually very hard. The water from dolomite and other rocks containing sulphate of lime resembles the chalk water, but it is not nearly so wholesome, owing to the bad effects which the sulphate of lime (gypsum, or plaster of Paris) produces on the stomach and other organs. The water from sandstones and deep alluvium is almost invariably very impure. Surface drainage and subsoil water are occasionally pure enough to be used for potable purposes, but, as a rule, they are to be regarded with suspicion. Marsh water and water contaminated with sewage impurities are extremely dangerous, and should never be used. The well water derived from the drainage of the surface of the ground is not so pure, as a general rule, as that obtained by sinking deep into the earth. The composition of shallow wells constantly varies, whilst that of very deep wells, and especially of that kind termed artesian, is nearly constant.

The ingredients of water used for domestic purposes are both gaseous and solid. The gases, chiefly obtained from the air, are oxygen, nitrogen, and carbonic acid. The proper amounts of these are stated to be 6 cubic inches of nitrogen, 3 cubic inches of oxygen,

and from $5\frac{1}{2}$ to 8 cubic inches of carbonic acid per gallon. The solid ingredients consist of organic matter and mineral substances. The organic matter is chiefly derived from decaying plants, but it is often in great part made up of animal matters—from sewers, grave-yards, and similar sources. The amount of organic matter should not exceed two grains per gallon (70,000 grains weight). The mineral substances are the well known bases—potash, soda, lime, magnesia, and oxide of iron, and sulphuric acid, carbonic acid, and chlorine. These acids and bases are generally found combined as the sulphates of potash, soda, lime, and magnesia, the carbonates of lime and oxide of iron, and the chlorides of calcium, magnesium, sodium, and potassium. There is very little potash in most of the potable waters. These substances should not exceed 70 grains per gallon, taken collectively, or if taken singly—

	Per imperial gallon.
Carbonate of soda ...	24 grains.
Common salt	16 "
Sulphate of soda	8 "
Sulphate of lime	5 "
Carbonate of lime	20 "
Sulphate of magnesia	4 "
Chloride of calcium	6 "
Chloride of magnesium	6 "

Larger amounts of carbonate of lime (chalk), carbonate of soda, and common salt might probably exist in water without rendering it injurious to health; but larger quantities of sulphates of lime and magnesia, and chlorides of calcium and magnesium, would, in my opinion, be likely to injuriously affect the alimentary canal.

The presence of nitric acid, nitrous acid, and ammonia in water proves that it is, in all probability, contaminated with sewage impurities. I have analysed specimens of water containing from 5 to 6 grains of organic

matter per gallon, and yet they were quite free from both nitrates and nitrites: it would be difficult to say whether or not such waters were wholesome. On the other hand, I have examined waters that contained only two grains of organic matter per gallon, and yet, from the highly ammoniacal residue which they left on evaporation, I could easily perceive that they were not fluids that could be safely drank during the prevalence of cholera.

The flavor of water is not always a reliable indication of its purity. When both taste and odor are bad, then the water is certain to be impure; but there are very pure waters which are far from being agreeable to the palate, and there are unwholesome waters which possess a very pleasant flavor. Spring or well water, containing not more then 70 grains of solid matter per gallon, and abundance of carbonic acid gas dissolved in it, is often sparkling, transparent, and well flavoured; but I have often detected in water of this kind a large amount of nitrites, nitrates, and ammonia. Some writers state that water should contain 10 or 12 grains of earthy salts per gallon, in order to supply lime and other materials to build up the framework of the body; but it is probable that water containing a sufficient amount of gases is most wholesome when the mineral matter does not exceed 3 or 4 grains per gallon.

In 1866 I examined—agreeably to the suggestion of Dr. Mapother—the water of some of the wells of Dublin, to which the general public had access, and also the pipe water supplied to the citizens. The results are shown in the table.

Analyses of Waters used for Domestic Purposes in the City of Dublin.

	Total amount of solid matters per gallon (70,000 grains).	Fixed Salts.	Volatile and combustible matters.	Organic matter (estimated).	Nitric Acid.	Nitrous Acid.
	Grains.	Grains.	Grains.	Grains.		
No. 1. A Pump in Farrell's yard, Marlboro'-street, within one foot of St. Thomas's Grave-yard	41.97	35.80	6.17	3.10	Large.	None.
No. 2. Carton's Pump, Halston-street	53.70	48 20	5.50	2.50	Small.	Traces.
No. 3. A Pump in stables, Prince's-street, North	40.43	35.98	5.45	3.20	Small.	Traces.
No. 4. A Pump in livery stables, No. 7, Queen-street	55.60	48.75	6.85	3.25	Large.	Traces.
No. 5, St. Nicholas'-well, livery stable yard, Francis-street	38.63	33.08	5.55	4.05	Excessive.	Large.
No. 6. A Pump in a stable yard, Lamb's court, Corn Market	39.93	33.98	5.95	3.86	Do.	Do.
No. 7, A Pump at 212, Gt. Brunswick-street	40.52	36.50	4.02	2.28	Moderate.	Faint traces.
No. 8. A Pump in Dycer's, Stephen's-green	50.37	44.24	6.13	2.[illegible]0	Traces.	Faint traces.
No. 9. A Pump in stable-yard, Lincoln-place	58.43	51.17	7 26	4.80	Considerable.	Considerable.
No. 10. Pipe Water, North Side, Peter-street	19.05	16.00	4.05	3.00	Traces.	Faint traces.
No 11. Pipe Water, South	14.04	10.64	3 40	3.10	Traces.	Traces.
*No. 12. Canal Water, Maquay bridge	22 16	16.10	5.06	4 20	Large.	Traces.
No. 13. Canal, near 4th Lock	14.56	10.62	3 94	3.40	Traces.	Traces.
No. 14. River Vartry	4.10	2.25	1.85	1.50	None.	None.

* The water taken from this part of the canal is used chiefly in Irishtown, Ringsend, and Sandymount. I have examined it several times, and found that it is occasionally so impure as to be semi-opaque. I have on several occasions seen the bilge water pumped out of boats, laden with manure, into this canal!

Table showing the amount of organic matters in waters used in various places.

	Grains per Gallon.
Glasgow Pipe Water (from Loch Katrine)	0.82
Liverpool Pipe Water	1.21
Manchester Pipe Water	1.25
Aberdeen Well Water	1.82
London (new river)	1.9. to 2.7
„ (Thames)	2. to 3.7
„ Well at Guildhall Buildings ...	2.
„ „ Bishopsgate ..	6.4
„ „ Aldgate	7.1
Chatham Well Water	5.
Norwich „	10.37
Brighton „	17.52

The water of the shallow wells of Dublin is, on the whole, purer than that of London. Not one of them contains five grains of organic matter per gallon. In ordinary times most of them might be used with perfect safety. In the pump water of several public institutions, large business establishments, and private houses, I have found excessive, and, as I believe, unwholesome amounts of mineral matter. The rock formation underlying the city and suburbs of Dublin is limestone mixed with black shale, and is known to geologists by the term *calp*. Resting on the solid rock there is a stratum of impure limestone gravel, averaging about 40 feet in depth. In several parts of the bed of the river Dodder dolomite, or magnesian limestone occurs, and this is especially the case in the neighbourhood of Milltown. It is the drainage of this limestone gravel that constitutes by far the larger portion of the well water of Dublin and its suburbs. In a few parts, however, of the southern suburbs the superficial wells are supplied by drainage from the dolomitized limestone. As might be expected, the Dublin well water is very hard, and is not suited for detergent purposes. It is, however, owing

chiefly to its large amount of carbonic acid and low temperature, a well flavored water, even when it contains excessive quantities of earthy salts.

There is one peculiarity of the Dublin well waters which is worthy of notice—that is, that whilst in some of them there are only minute traces of sulphate of lime (gypsum), in others there are from 10 to 90 grains per gallon of this most undesirable ingredient. In fourteen specimens I have found more than 25 grains of gypsum. In the water of the pump at the University Club, St. Stephen's-green, I found the enormous amount of 168 grains of solid matter per gallon, of which no less than 84 grains were sulphate of lime, 30 grains of chloride of calcium, and 20 grains of chloride of magnesium. There were only 2 grains of organic matter in this curious water; and I have generally found that waters in which large amounts of gypsum occur do not contain much organic matter. The presence in water of more than 3 grains per gallon of sulphate of lime is considered to be injurious. Water containing from 5 to 10 grains per gallon of this ingredient is, I know, constantly drank without invariably producing disease, but it is impossible that water like that of the University Club pump could be used with impunity. Indeed, I have learned that persons who drank this water suffered much from dyspepsia and severe diarrhœa, the cause of which was inexplicable to them until the nature of the water which they drank was ascertained.

The presence of enormous amounts of sulphate of lime in some of the superficial wells of Dublin appears the more surprizing from the fact that the drainage does not come in contact with selenite or beds of plaster of Paris. The circumstance may, however, be explained in this way:—There is a large amount of amorphous sulphide of iron in the black shale, which, as I have already stated, enters into the composition of the calp: by oxidation this sulphide of iron is converted into

sulphate of the same metal, and the sulphate reacting upon the carbonate of lime (which is the most abundant constituent of the calp) produces sulphate of lime and carbonate of iron. The reaction is best shown in the diagram :—

Sulphate of oxide of iron	Sulphuric acid Oxide of iron	Sulphuric acid Lime	Sulphate of lime
Carbonate of lime	Lime Carbonic acid	Oxide of Iron Carbonic acid	Carbonate of iron

The "hardness" of water is due to the presence of compounds of lime and magnesia. Carbonate of lime, or chalk, is the most common cause of the hardness of water. This substance is not soluble in pure water, but a solution of carbonic acid gas readily dissolves it. Spring, well, and even river waters contain carbonic acid, and often in large quantities, and when they come in contact with chalk they dissolve it. If these kinds of water be boiled they become soft, because the carbonic acid gas is driven off, and the chalk having lost its solvent is thrown down in a solid form. This is the most common cause of the earthen encrustation on boilers, tea-kettles, and similar vessels. When the hardness of water is due to the sulphates of lime and magnesia, and the chlorides of calcium and magnesium, then boiling will not soften it, as all those salts are more or less soluble in pure water. The waters of the Dublin canals, and of some of its wells, may be rendered soft by boiling, but most of the pump waters which I have examined are permanently hard.

I shall now explain why it is that hard water is not suitable for detergent purposes. Soaps are the products of the action of alkalies upon animal or vegetable fats and oils. Fats are compounds of glycerine with various substances, such, for example, as oleic acid, stearic acid, and margaric acid—which, however, are not, as their names might imply, sour to the taste. When a

fat is boiled in a solution of an alkali, say soda, the glycerine is displaced by the alkali, and a soap is formed. The soaps of the alkalies, potash and soda, are soluble in water; but there are other soaps, for example, those containing lime, which do not dissolve in that fluid. When, therefore, we try to wash with hard water, the lime decomposes the soda soap, and uniting with its fatty acid, forms an insoluble compound, or curd.

All the earthy salts render water hard and cause a great waste of soap. When the hardness of water is due to the presence of chalk, simple boiling will prove an effectual remedy, provided the water be not used until the chalk has subsided from it, and the clear fluid is decanted off the sediment. Clark's process for softening this kind of water consists in adding lime water to it. The excess of carbonic acid, which holds the chalk in solution, unites with and throws down the lime, and the chalk having lost its solvent is precipitated at the same time. The difficulty in carrying out this process is to ascertain the proper quantity of lime water to employ; for if an excess be applied, the remedy will be worse than the defect. I think, however, that the addition of 2 gallons of lime water to 100 gallons of tolerably hard water will never prove an excessive quantity, and will be certain to improve the quality of the water.

Dublin is now partly, and will soon be wholly, supplied with water from the Vartry, a river which drains an area of 22 square miles of mountainous district in the county of Wicklow. The water is conveyed through huge iron tubes from the great reservoir (420 acres in extent) at Roundwood a distance of 22 miles; and is sufficient in quantity to supply 12,000,000 gallons per day, or 35 gallons per head of the population who are expected to use it. The undertaking has cost the citizens about £400,000, but it is my firm conviction that the money has been well expended, and that the abundant supply of pure water now provided for the city will greatly tend

to promote the health and comfort of the citizens. The credit of carrying to a successful issue the scheme for supplying Dublin with the Vartry water is chiefly due to Sir John Gray, M.P.; but he was cordially supported by many of the leading members of the Corporation, and ably assisted by the city engineer, Mr. Parke Neville, to whom the onerous duty of superintending the works has been entrusted.

The Vartry water is, as I have already shown, extremely pure, containing, as it does, only two grains of mineral matter, and less than two grains of organic matter, per gallon. By its use a large quantity of soap will be saved to the citizens; and clothes can be washed in it with less friction. A bath in this extremely soft liquid is an enviable luxury. Hard water is not even suitable for cooking food. It does not extract all the soluble matter from meat, and therefore should not be used in preparing soup. Infusion of tea made with hard water is often perfectly undrinkable, and in any case the lime renders a portion of the more valuable ingredients of the tea insoluble and useless. Peas and some other vegetables, when boiled in very hard water, do not lose their hard texture. I have performed a great many experiments with the Vartry water, from the results of which I have come to the conclusion that its use, for detergent and cooking purposes, will effect a saving in the expenditure of the Dublin public for clothes, soap, and food equivalent to several thousand pounds sterling per annum.

Soft water dissolves lead; the Vartry water cannot, therefore, be safely stored in pure leaden cisterns, or conveyed in pipes formed of that metal. I find that an alloy composed of 96½ parts of lead and 3½ parts of tin is not affected by the Vartry water; and the Corporation of Dublin prescribe the use of this alloy for the conveyance and storage of the Vartry water. It should also be used in cisterns intended to receive rain, or any

other kind of soft water. Leaden pipes through which hard waters have flowed for some months are coated with insoluble compounds of lead and encrustations of earthy salts: on those tubes the softest water exercises no injurious influence.

The Vartry water delivered in Dublin, being derived from a reservoir which is situated at a much greater elevation than the city, exerts great pressure upon the water pipes, and is capable of ascending through them to a considerable height.

The great danger attending the supply of water at high pressure is the bursting of house pipes, either by the force of the water or—as in the case of any other kind of water—by its sudden and rapid expansion in the act of freezing. However, by cutting off the supply where it enters the house, and leaving the mouth of the pipe open, the risk of bursting by pressure is avoided; and if the pipes be kept empty, except when the water is actually running, they cannot be burst by frost.

An arrangement known as "Kidd's patent safety apparatus" has been brought into use lately, to accomplish these objects automatically. Like many other inventions, it has been found in the actual working of it that its construction could be simplified, and, at the same time, its action rendered more complete. The diagrams explain its improved construction.

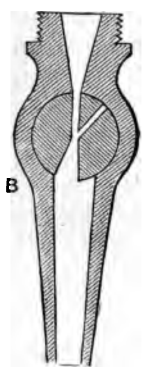


FIG I.

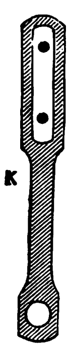
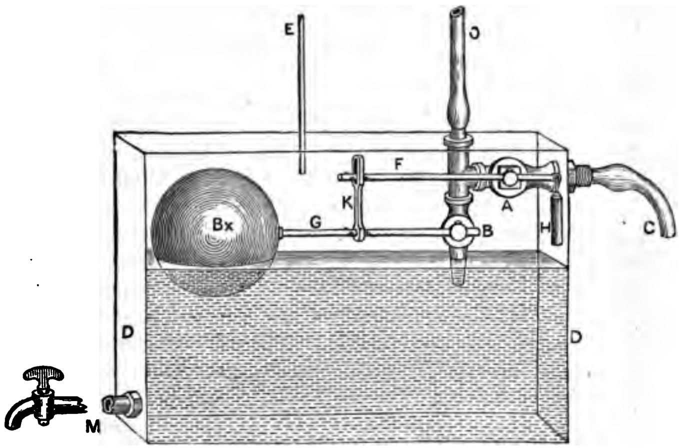


FIG 2.

Two cocks, A and B, figure 3, are placed on the supply main C. Where it enters the house, a small metal tank D, similar to those used for regulating the supply to kitchen range boilers, is placed underneath, and a "notice" or overflow pipe E is conducted into this tank from the highest house cistern. The lever of cock B carries a large copper ball Bx, and is connected

FIG 3.



with the lever of cock A by a link K, also shown in fig. 2. Cock B has two apertures in it, as shown at figure 1, and discharges into tank D. From the bottom of the tank a pipe M opens, which may be taken to any distance, or have any number of branches. It is intended that all the water used in the basement story should be taken from this pipe M, and when the tank D is emptied and the ball Bx sinks to the bottom the cock A opens, also the cock B, and an unlimited supply is obtained from M. When enough has been obtained and M is closed, water accumulates in tank D until the ball rises sufficiently to close cock B.: the cock A now remains open, in consequence of the slot in the link K, and the water passes into the house until it fills all the cisterns, upon which the overflow comes down, completely fills the tank D, and raises the ball until it closes cock A, and opens the second aperture in cock B, allowing the water lying in the pipes to run off. Thus every time water is re-

quired in the basement it is turned on into the house, and runs until all the cisterns are full; it is then cut off at the point where it enters, and the pipes are emptied. You will now perceive that this apparatus performs its work automatically, and quite independently of the interference of servants, who, indeed, are not required to have any knowledge of its mechanism. That it effectually prevents the bursting of pipes, either from frost or high pressure, is a matter beyond doubt.

In most towns, more especially in Ireland, the water supplies are very impure, being, in the case of the smaller towns and villages, the produce of superficial wells, in which, more or less, sewage impurities are necessarily present. Shallow wells in unsewered towns are certain to contain animal matter. The water used in the smaller towns should be obtained from very deep wells—for the deeper the well, the greater is the drainage area—or, what is still better, obtained from a neighbouring stream, or lake of pure water. I have analysed the water used for domestic purposes in many of the second, third, and fourth-rate Irish towns, and, except in one or two cases, I invariably found it more or less impure. Dr. Mapother has forcibly pointed out the inadequate quantity and unwholesome nature of the well water of many of the towns and villages of Ireland.

The quantity of water required daily for an adult is, on the average, from ½ to the 7-10ths of an ounce per pound weight of the body. A man weighing 10 stones uses about 80 ounces, or 8 imperial pints of water per diem, of which about 28 ounces forms part of his solid food, and the rest is consumed in a liquid form.

The minimum amount of water daily required for personal ablutions, washing clothes and rooms, and for cooking is four gallons per head. To perform these operations thoroughly, however, requires about 20 gallons, and with this quantity, complete, hip, or shower baths may be frequently taken. Twenty-five gallons of

water per head per day supplied to a house will be found ample for every purpose requiring the application of water. The Vartry river is capable of supplying the inhabitants of Dublin and its suburbs with at least 25 gallons per head, without taking into account the quantities necessary for manufacturing purposes, washing the streets, flushing the sewers, and extinguishing fires.

Rain water caught on the roofs of houses is largely used for potable purposes. It is very soft, contains in general only minute traces of mineral matter, but it holds much gaseous matters in solution. In country districts rain water is usually very pure; but in towns and populous suburban localities it often contains soot, coal ashes, and various other matters which it meets with in its descent through the air or on the house tops. The more serious impurities of rain water appear to me to be the result of the common practice of storing it in uncovered barrels or open cisterns, in situations convenient to the ash-pit. In the greater number of small and medium-sized houses the water butt and ash-pit are close neighbours; and when the servant discharges the contents of the dust-pan or other vessel into the refuse receptacle, a portion of them, in the form of dust or of larger particles, is certain to find its way into the water barrel. I have frequently examined the sediment from the rain water stored in suburban houses, and almost invariably found it to contain coal ashes, vegetable refuse, and similar matters. I would, therefore, recommend that as wide a space as possible should separate the ash pit and water cistern. Water barrels and cisterns and their conduits require to be cleaned very often, and those vessels should be carefully covered, and the water, when required, drawn off by means of a stop-cock.

A rain fall of 30 inches per annum delivers 678,000 gallons of water an acre, or about 212 gallons on each square yard. In order, therefore, to estimate the supply of rain water, it is only necessary to ascertain the amount

of the rainfall and the area of the roof or other surface on which it is caught.

Several maladies are directly produced, and others indirectly induced, by the constant use of bad water. The repulsive disease termed goitre—an enormous enlargement of the thyroid gland—and the imbecile condition known as *cretinism*, are produced by the use of water containing large amounts of lime and magnesia salts. This disease is very common in the valleys of the Alps and Pyrenees, and in many parts of Asia and South America—especially in India and Brazil. This complaint is not a common one in Great Britain; but such cases as have been met with have been clearly shown to be the result of the use of water containing excessive quantities of earthy salts. Dyspepsia, constipation, dysentery, and diarrhœa are the most usual diseases produced by calcareous and magnesian waters, more especially when much sulphate of lime is present. In the case of many of the wells of Dublin and its suburbs, I was able to ascertain that the enormous amounts of sulphate of lime and chlorides of calcium and magnesium which they contained developed serious diseases of the digestive organs. During the Mexican War, in 1861-2, several hundred French soldiers stationed at Orizaba suffered severely from diarrhœa, induced by the use of water containing an excessive proportion of organic matter. Numerous outbreaks of typhoid fever have been clearly traced to the use of water contaminated with sewage matters. In 1860 this disease broke out in a convent at Munich: 31 out of 120 inmates were affected. On analyzing the well water supplied to the convent, it was found loaded with organic matter and nitrites; and on replacing the foul fluid by a purer element, the disease was at once arrested. Dr. Parkes states that a sudden and localized outbreak of the disease is almost certain to be due to the introduction of the poison by water. I could, were it necessary, quote hundreds of instances in

which typhoid fever was clearly traced to the use of water contaminated with effete animal matters.

There is the clearest evidence that cholera is infectious, and that the virus of this disease is frequently conveyed through the medium of water. The Reports of the Medical Officer of the Privy Council, and of the great majority of the Medical Officers of Health, prove that, during the epidemics of 1853 and 1866, the ravages of the disease were most severely felt in the districts where the water was least pure. Dr. Mapother and myself succeeded in several cases in clearly proving that the cholera virus was propagated by means of drainage water.

Malarious fevers are generally the result of breathing the air of marshes, but it would appear to be sometimes produced by water containing an excessive amount of decomposing vegetable matter.

Entozoa, or internal parasites, are not unfrequently introduced into the body by means of water. Some forms of tape-worm are believed to enter the body in no other way. The round worm, *ascaris lumbrici*, is often swallowed in drinking water.

The lower animals suffer very often from the bad quality of the water supplied to them. Horses go out of condition if they drink very hard water, especially that containing sulphate of lime—which, indeed, is said to produce exostosis, or abnormal growth of bone, in those animals. According to Gamgee, earthy waters produce calculi in sheep. The foul and stagnant water usually supplied to oxen cannot but act prejudicially upon the health of those animals.

The organic matter contained in water may be destroyed by the action of powerful oxidizing substances, or it may be removed by filtration through charcoal. The best chemical purifier of water is solution of permanganate of potash (Condy's fluid); on mixing this crimson-colored fluid with impure water, it acquires a

brownish color, because when decomposed it loses the larger portion of its oxygen, which unites with and mineralizes the organic matter. Water purified in this way cannot well be drank until the insoluble oxide of manganese—the harmless residue of the permanganate of potash—has subsided. Alum, lime, soda, and various other substances, are used for purifying water, but they are much inferior for that purpose to Condy's solution.

Filtration through animal charcoal removes the organic matter. One gallon of the water No. 13, referred to in the table, page 26, on being filtered through a layer of animal charcoal, 2½ inches deep, had its organic matter reduced from 3.40 to 0.2 grains per gallon. One pound weight of animal charcoal is sufficient to purify from 50 to 100 gallons of water, and when its powers are exhausted they may be restored by heating the charcoal to redness for a few minutes.

There are a great number of filters in use, but I only recommend those that contain charcoal, especially when provision is made for the frequent renewal of the purifying material. Mr. Maguire, of Dawson-street, Dublin, has constructed an excellent charcoal filter on this principle. Some authorities contend that charcoal does not perfectly remove the virus of cholera, nor, probably, of other diseases, from water; and if zymotic diseases are propagated by means of low forms of vegetable life, it is most likely that charcoal exercises no effect upon such organisms. I believe, however, that there are putrescent animal and vegetable matters in impure water, which, though not specific animal poisons, are yet capable of inducing disease if permitted to enter the body: these substances are unquestionably destroyed by charcoal. From the results of several experiments, I have come to the conclusion that the more putrescent organic matter is, the more readily is it attacked by charcoal, and that the organic matter which passes through the filters is chiefly peaty or woody particles, not in a

state of decay. By boiling water the vitality of the organisms contained in it is destroyed. When cholera, or any similar disease, is epidemic, it is, therefore, advisable to boil water before filtering it. Water loses its flavor under these circumstances, but it can be restored, in great part at least, by pouring the fluid from one vessel into another, and back again, twenty or thirty times. During this operation the water is aerated by absorbing carbonic acid and other gases from the atmosphere.

Filtration through sand is useful, because it removes the impurities mechanically suspended in water. Vegetable charcoal is greatly inferior to animal charcoal. Charred wood in large lumps placed in water barrels proves very useful.

Seamen are often obliged to use very impure water. When shipping this indispensable fluid, the commanders of vessels should obtain it from the *best*, and not, as is usually the case, from the *nearest* source. The tanks or casks should be examined whenever the ship gets into harbour, and if necessary—which is almost certain to be the case—they should be thoroughly cleansed. The interior surface of the casks should be charred, and to each of them a few lumps of wood charcoal would be a useful addition. Every vessel, more especially those carrying passengers, should be provided with at least one large and perfect filtering apparatus. On long voyages the water is pretty certain to become tainted, however pure at first, but it may be preserved in drinkable condition by the use of the permanganate solution. It is probable that a small quantity of carbolate of lime, or, still better, carbolate of soda, dissolved in the fresh water would preserve it for several months; 1 part of the carbolate in 10,000 parts of the water would be, I think, a sufficient quantity for this purpose. Large vessels are now sometimes provided with a distilling apparatus, by means of which salt water can be converted into fresh.

LECTURE III.—ON THE ATMOSPHERE AND METEOROLOGY.

I hope to be able to show in this lecture, and in two or three future ones, that the health of man and of many of his "subjects in creation" depends in no small degree upon the purity of the air which they breathe. The atmosphere extends to a height of 45 miles—or, according to some observers, 70 miles—from the level of the ocean, decreasing in weight as it recedes from the earth's surface. A cubic foot of dry air, free from carbonic acid, weighs 537 grains (nearly 1⅛ ounces), when the thermometer stands at 32 degs. Fahrenheit, and the barometer at 30 inches. A column of air extending from the ground to the extreme limits of the atmosphere balances a column of mercury 30 inches in height, and one of water 34 feet in height; and it presses upon the surface of bodies with a force equivalent to 15 lbs. weight upon each square inch. At the summit of Mont Blanc half the weight of the atmosphere is lost, the mercury in the barometer sinking to 15 inches. The enormous force which the atmosphere exercises upon the surface of the body is not felt, because the pressure is equably applied. When I spread out my hand the upper surface is pressed upon by the superincumbent air, but the under surface is sustained by an equal force, derived also from the atmosphere; and thus my hand is kept in equilibrio.

The atmosphere is a complex fluid, consisting of several gases and vapors, in a state of mere mechanical admixture.

Average composition of the Atmosphere.

Essential.	Nitrogen	... ...	77.95
	Oxygen	... ...	20.61
	Watery Vapor	... ...	1.40
	Carbonic Acid	... ...	0.04
	Ozone...	... ...	Traces.
	Ammonia	... ...	
Non-Essential.	Nitric Acid	... ...	Traces.
	Carbonic Oxide	... ...	
	Carburretted hydrogen	...	
	Sulphuretted Hydrogen	...	

In addition to these substances, many others frequently occur, especially in the air of towns. For example, sulphuric, sulphurous, muriatic, and nitrous acids, chlorine, phosphuretted hydrogen, common salt, and an immense variety of organised and organic bodies. I propose to describe the nature of the normal ingredients of the air first, and then we shall pass on to the study of the matters that are looked upon as impurities.

Oxygen gas is the most important constituent of the atmosphere; for most of the functions discharged by that fluid are in reality performed by oxygen. The respiration of animals and the ordinary processes of combustion are solely maintained through its agency; and the great changes continuously passing over the face of nature are chiefly the result of the action of this potent element. Oxygen is about one-tenth heavier than atmospheric air. It is destitute of color, odor, and flavor: 100 gallons of water dissolve between three and four gallons of it. No animal can exist in air which has been deprived of its oxygen, and fishes speedily expire when placed in water free from this vital element. Oxygen destroys the organic matters found in the air and in soils, by uniting with their carbon and hydrogen, and converting those elements into the minerals, carbonic acid, and

water. It also destroys vegetable colors, a property of which the linen and cotton manufacturers largely avail themselves, exposing their brown or yellow fabrics to the bleaching action of the air.

Ozone is oxygen gas in some peculiar condition, the precise nature of which is not thoroughly understood. It is about one-twelfth heavier than ordinary oxygen, and, unlike that body, is insoluble in water. It possesses an odor which some compare to that of diluted chlorine ; others to that of phosphorus. You can smell it during a thunderstorm, when a phosphorus match is being lighted, or when an electrifying machine is developing electricity. Ozone is a powerful bleacher, and readily decomposes several chemical compounds. It is probable that some of the effects of atmospheric air upon animals and vegetables, and their products, are produced by ozone. This remarkable body is formed by passing electric sparks through the air, or by slowly oxidizing moist phosphorus. The oxygen evolved by the decomposition of water by means of a galvanic current generally contains a little ozone.

A piece of paper or linen, soaked in a solution of starch and iodide of potassium, is a test for the presence of ozone, acquiring a blue or lavender tint on exposure to air containing a very minute trace of ozone. This curious substance is seldom met with in towns, in overcrowded rooms, or places where the air is very impure. It is most abundant in the air above the ocean, and is seldom found absent from the atmosphere of the open country.

Nitrogen is by far the most abundant constituent of the atmosphere. It is colorless, tasteless, and odorless. It is a little lighter than atmospheric air. One hundred parts of water dissolve only two parts of this gas. Nitrogen cannot support combustion or respiration; but by diluting the atmospheric oxygen, it renders that gas less stimulating to animals. An atmos-

phere of pure oxygen would cause so rapid an expenditure of the tissues of an animal that death would result, in most cases, in a short time. The relative proportions of oxygen and nitrogen in the atmosphere do not sensibly vary. Specimens of pure air, collected at great heights above the level of the ocean, and from profound depths below the surface of the earth, have been found to contain identical relative amounts of oxygen and nitrogen.

Watery Vapor varies considerably in amount, being sometimes so low as 0.5 per cent., at other times so high as 4 per cent. The average amount is about 1.4 per cent. The warmer air is, the greater is its power of maintaining water in a vaporous state.

Carbonic Acid Gas is a compound of the elements carbon and oxygen. It is as heavy and a half as atmospheric air. It has no color, but possesses a pungent odor, and its solution in water is slightly acid. It is fatal to animal life, even when largely mixed with atmospheric air; and a lighted taper is extinguished in air containing only a small per centage of this gas. It is extremely soluble in water, in which fluid it is invariably present, and often in large amounts. Carbonic acid in a few parts of the world issues in a pure state from fissures in the earth. It is this gas which is driven off from limestone, when that substance is ignited in kilns; and its presence imparts to champagne, bottled malt liquors, and mineral waters much of the *piquant* flavor which those beverages possess.

The amount of carbonic acid gas in the air varies from 2 to 6 parts in 10,000 parts of air; the average is .04 per cent. It is sparingly present after rain, and accumulates during seasons of drought. It is more abundant in summer than in winter, at night than during the day, and over water than above land, Up to 11,000 feet elevation it increases slightly in amount, but at that altitude it begins to decrease.

Carbonic acid gas furnishes the largest portion of the

carbon used as food by plants; and the nitrogen of vegetables is to a great extent derived from ammonia. It is evident, then, that these gases are normal ingredients of the atmosphere, and it is not likely that, unless when present in excessive proportions, they exercise an injurious influence upon animal life.

Carbonic acid, though food for plants, is poisonous to animals if taken into the lungs in large quantities. When limestone (carbonate of lime) is ignited, nearly half of it is dissipated in the form of carbonic acid. Many poor, homeless creatures have lain down close to the lime-kiln fire, to enjoy its warmth, but, succumbing to the narcotic influence of the carbonic gas, have fallen into a sleep from which they never awoke on this earth. The carbonic acid which accumulates in brewers' vats, in the holds of corn-laden vessels, and in some other situations, has often caused the death of persons who incautiously descended into it.

Ammonia is a compound of hydrogen and nitrogen. It is a pungent gas, much lighter than air, and is very soluble in water. According to a French chemist—M. Ville—28,000,000 parts of atmospheric air contain 1 part of ammonia. In the air of Manchester Dr. Angus Smith found a larger proportion, namely, one grain in 412.42 cubic feet, or 0.000453 per cent.

The amounts of sulphuretted hydrogen, carburetted hydrogen, organic matter, and the various other bodies which occur, as I believe, accidentally in the air, vary very much; but in general they constitute unweighable traces. In the air over the ocean the amounts of organic matter and sulphuretted hydrogen must be almost inconceivably minute. Common salt and carburetted hydrogen do not vitiate the air to an extent worth taking into account. Carbonic oxide is injurious to animals if even but one-half per cent. of it be taken into the lungs. Air containing one per cent. of this gas proved rapidly fatal to animals. Sulphuretted hydrogen and phosphuretted

hydrogen are very poisonous gases, and persons have more than once lost their lives in consequence of descending into sewers and manure tanks, the air of which contained a large proportion of sulphuretted hydrogen. The organic vapors and particles, floating about in the air, appear to be more injurious to animals than are all the other abnormal ingredients.

When atmospheric air is sensibly altered in composition, its effects upon animals are also modified, and often to a considerable and injurious extent. A trifling diminution in the amount of oxygen does not render air less wholesome, provided that the deficiency is made up by an excess of nitrogen. When, however, oxygen is deficient, it is generally found that carbonic acid is in excess. When the proportion of oxygen sinks below 20.5 it may fairly be assumed that the air is decidedly vitiated. On the other hand, when the percentage of oxygen rises to 21 there is little doubt but that the air is pure.

Table showing the proportion of Oxygen in Air.

Authority.	Place	Percentage of oxygen.
Lewy	Atlantic Ocean, midway between Africa and America...	20.96139
"	British Channel ...	20.96321
"	Bogota	21.02099
Dumas and Boussingault	Paris	20.810
Stas	Brussels	20.865
Marignac	Geneva	20.784
Frankland	Summit of Mont Blanc	20.963
Brunner	Foulhorn	20.910
Miller	18,000 feet high (collected from a balloon)	
Regnault	Toulon Harbour ...	20.850
"	Bengal Bay, over bad water	20.387

Authority.	Place.	Percentage of Oxygen.
Leblanc	Chemical Theatre, Sorbonne, before lecture	20.760
„	After lecture	19.860
„	Close stable, Ecole Militaire ...	20.39
Angus Smith	Street and suburb air, Manchester (mean of 32 analyses) ...	20.943
„	Gallery of theatre, Manchester ...	20.630
„	Large cavities in mines ...	20.770
„	Under shafts	20.424
„	In mines where candles go out ...	18.500

The fluctuations in the amount of atmospheric carbonic acid are very great. Four parts in 10,000 may be looked upon as a normal proportion. A current of air free from organic matters, but containing 1 part of carbonic acid gas in 1,000, may be breathed without any bad effect being perceived. In soda water manufactories, where the air contained 2 parts per 1,000 of carbonic acid, no discomfort was experienced by the workmen.

Table showing proportion of Carbonic Acid in Air at different places.

Authority.	Place.	Percentage.
DaLuna	Madrid—	
	Outside the walls—	
	maximum	0.0900
	minimum	0.0200
	mean	0.0800
	Inside—	
	maximum	.0200
	minimum	.0450
	mean of 12 analyses...	0.0520
De Saussure	Geneva (mean of 13 analyses)	0.0468

Angus Smith	London, top of monument	0.0398
	Mean of 25 analyses of London street air ...	0.0341
Smith and Bernays	Olympic Theatre, London	0.1014
	Pit of City of London Theatre ...	0.252
	Standard Theatre (pit)	0.320
Smith	Manchester streets ...	0.0403
	„ close places	0.1604
Pettenkofer	Air of Munich ...	0.0500
„	Bed-room with closed windows ...	0.2300
„	Bed-room with open windows ...	0.0820
„	Overcrowded school-room	0.7230
Roscoe	Unventilated barracks (London) ...	0.1242

The organic matters in the atmosphere consist of a great variety of bodies. They comprise seeds, spores, pollen, minute vegetables, infusoria, insects and their remains, soot, fragments of linen, cotton, silk, and wool, hairs, particles of animal and vegetable substances. Minute traces of matters thrown off from animals exist in the air, and constitute the most dangerous part of the atmospheric organic matter. Pus has been detected in the air of hospitals, and epithelium from the skin may be found in the dust of most inhabited rooms. Chalvet collected the dust in a badly-cleaned and ill-ventilated hospital, and found it to contain from 33 to 46 per cent. of organic matter.

Table showing amount of Organic Matter in Air.

	Cubic feet.
Pure air on high ground, 1 grain in from	176,000 to 209,000
In a bed-room	„ 56,000

		Cubic feet.
Inside a house	... ...	16,000
In a closely-packed railway carriage		8,000
Air of a cess pool	...	62

The experiments of Dr. Angus Smith clearly prov that the head-ache and other symptoms which we suff from in ill-ventilated places are nearly altogether the r sult of the organic matter, and not of the carbonic aci of the vitiated air. Hammond found that a mouse die in 45 minutes in air containing a large amount organic matter, but no carbonic acid. Other exper ments have afforded similar results.

The physical condition of the atmosphere is a poi of considerable hygienic importance. At great heigh above the surface of the ocean the pressure on the boc is much diminished, the circulating fluid is impelled wi greater rapidity through the vessels, and the respiratio are proportionately increased. A pleasurable exciteme is experienced, and the desire for muscular exercises exhalted. The advantages of mountain air are man The light is less obscured in passing through it; tl quantity of moisture in it is small; there is the mere trace of organic matter, and no infusorial animals, in The air of upland regions—say from 3,000 to 7,0 feet elevation—has been found most useful in the trea ment of dyspepsia, anæmia, gout, and scrofula. At height of from 5,000 to 7,000 feet, rheumatic patien often find their painful malady much improved. Infla mation of the lungs and acute bronchitis do not appe to be removed by mountain air. There is some dou as to the efficacy of mountain air in the treatment of pu monary consumption; but it is remarkable that the pe sons who live in very elevated regions rarely suffer fro this disease. Malarious fever is seldom, if ever, contract at great heights. According to Carriere and Blak malaria never ascends beyond—

In Italy	From	400 to 500	feet.
America (Appalachia)...		3,000	„
India		2,000 to 3,000	„
West Indies ...		1,400 to 2,200	„
California		1,000	„

Although it is obvious that the temperature of the air is a point of hygienic importance, the relation between heat and disease has been by no means satisfactorily determined. There is a general opinion that cold climates are healthy, and that very hot ones are the reverse; but it is probable that the insalubrious condition of many hot countries is due to malarious exhalations, and not to the high temperature of the air. The natives of the British Islands appear to thrive better in countries as cold or colder than their own than in hot climates. The Canadians and New Zealanders of British origin are certainly a hardier race than the West Indian Creoles of pure English or Irish descent. In tropical climates in the East, Europeans degenerate so rapidly, that in the course of three or four generations they generally die out, unless they intermarry with the natives. It is the opinion of some authorities that Europeans are capable of as effectively working both mind and body in tropical climates as in their native countries; but I think there is evidence enough to prove that great and prolonged mental and physical vigor is not promoted by air at 100 degs. in the shade.

Extreme cold is not common in these countries, the thermometer seldom falling below the freezing point. In Ireland the mean temperature in winter is 41·5, degs.; in summer, 60 degs.; annual, 54 degs. In the extreme north of the island the mean annual temperature is 3 degs. lower than in the extreme south. The mean spring temperature at Queenstown, county of Cork, is 50 degs., which is about the highest in Great Britain at that season. The mean annual temperature of England is 49·5 degs.; of Scotland, 47·5 degs.; of Guern-

sey, 50·2 degs.; of Isle of Man, 47·8 degs.; Marseilles, 59·5 degs.; Toulon, 62 degs.; Paris, 51·2 degs.; Rome, 59 degs.; Palermo, 62 degs.; Berlin, 46·5 degs.; Vienna, 49·5 degs.; Trieste, 55 degs.; Calcutta, 79 degs.; Madras, 83 degs.; Bombay, 84 degs.; Neilgherries, India (7,300 feet elevation), 57 degs.; Archangel, 12 degs.; Gottenburg, 14 degs.; Melville Island, 1.7 degs.; Arctic regions, nearly zero. The highest annual temperature—90.5 degs.—is at Massava, near the Red Sea, and on the Nile, in Lower Nubia. The greatest temperature (145 degs.) has been observed in India; the lowest, 92 degrees *below* zero, in 55 degs. N. lat. A Russian army, in an expedition to China, in 1839, was exposed for several days to the intense cold of 42 degs. below zero, and suffered severely in consequence.

The temperature of the sea varies (except when frozen) from 32 degs. to 81.5 degs.: that of the North Sea is 50 degs.; North Atlantic, between 50 degs. S. and 50 degs. N., 71.6 degs.; South Atlantic, between 50 degs. S. and 50 degs. N., 66·7 degs.; North Pacific, 69·9 degs.; South Pacific, 67·7 degs.; Indian Ocean, 69·3 degs.; Black Sea, 56·8 degs.; Western Mediterranean, 65 degs.; Eastern Mediterranean, 69 degs. The highest temperature—94 degs.—was observed in the Red Sea, near Aden. The greatest mean annual temperature, namely, 84·5 degs., to the east of New Guinea. The mean annual temperature of the ocean near Great Britain and Ireland is about 52 degs. A warm current of water, familiarly known as the Gulf Stream, flows north-eastwards from the Gulf of Mexico and reaches beyond the Orkneys. It carries with it a large store of heat from the warm southern latitudes, which, gradually escaping into the air, increases the temperature of the British Islands by at least 25 degs. in winter. A current of cold water from the icy seas of the north flows southwards, bathing on its way the east coast of North America, and lowering its temperature through many degrees.

Sudden and great changes of temperature rarely fail to produce disease; therefore equable climates are, *cæteris paribus*, more healthy than those in which the range of temperature during a season is extreme. The range of temperature is greatest in dry climates and temperate regions, and least in very high latitudes, in the tropics, and in wet climates. The west and south-west parts of these islands have a more equable temperature than the north-east and south-east parts. Low temperature in the British islands produces a high death-rate; and it often happens that cold kills more people in a month than are carried off by cholera in the same space of time. In the early part of last year the extreme cold that prevailed nearly doubled the death-rate in Dublin and London. A table constructed by the Rev. Dr. Lloyd shows the relation between the temperature of countries and the mortality of their inhabitants—

Countries.	Excess of summer over 50°	Defect of winter under 50°	Deaths per 1,000
Italy and Turkey	+ 25	——	33
France and Austria	+ 18	——	26
Central Germany	+ 15	——	22
British Islands	+ 12	—13	21
Belgium	——	—16	23
Holland	——	—18	26
Prussia	——	—22	28
Russia	——	—36	37

The quantity of moisture in the atmosphere depends to a great extent upon temperature. Air at 32 degs. can perfectly dissolve, so to speak, the 160th part of its own weight, at 59 degs. the 80th part, and at 86 degs. the 40th part. Every increase of 27 degs. of temperature in air doubles its capacity for holding water in solution. If the temperature of air saturated with watery vapor be lowered even one degree, sensible moisture is produced. What is termed the *dew point* is simply the

temperature just above that at which air begins to precipitate its watery constituent. The number 100 being taken to represent air saturated with moisture, per centages may be used to express the relative humidity of the atmosphere. Twenty-nine is the lowest degree of relative humidity ever observed in these countries; but in African deserts it has fallen so low as 10. In Ireland it averages 88, but it has been so high as 93. In elevated regions and in high latitudes the amount of moisture in the air is usually very small, and the atmosphere is, therefore, clear and bright.

The evaporation of water from the animal body is retarded when the air is loaded with aqueous vapor, and is much accelerated by hot, dry winds; in both cases discomfort at least is experienced by most persons.

A relative humidity of between 70 and 80 is considered the most pleasant, and is probably the most healthful. The east wind in spring is very dry, and robs the body of much of its moisture. Many persons feel very cold when exposed to this unhealthy wind, even when the thermometer registers 60 degrees. In chronic diseases of the lungs very moist air has been found beneficial; and in the humid atmosphere of the peninsula of Dingle, in the county of Kerry, phthisis is a rare complaint. Malarious diseases are most prevalent in very damp atmospheres, and small-pox is most virulent when the air is saturated with moisture.

The rainfall of a country probably affects in some way the health of its inhabitants; but we have not sufficient data to enable us to speak positively on this subject. In parts of Peru and in some of the deserts of Asia and Africa no rain ever descends. On the Khasyah Hills, 200 miles from the Bay of Bengal, the enormous quantity of 600 inches of rain falls annually; on the West Ghauts, 263 inches; Singapore, 90 inches; Barbadoes, 72 inches; Bahamas, 52 inches; in North America, 20 inches in California, increasing northwards until at

Sitka, in North-west America, it reaches 90 inches. In European countries, the wettest are those that lie to the west and north-west. In Germany the rainfall is not more than 20 inches; in France, 30 inches; in the east of England it is about 24 inches; but in the west, on the plains, it is above 35. At Dublin, about 30 inches fall annually; at Belfast, 35 inches; and near the west coasts of Ireland, from 38 to 45 inches. In the mountainous region of the western and north-western parts of these islands the rainfall often exceeds 100 inches, and is sometimes 150 inches per annum.

The rainfall in some countries is distributed over a large proportion of the year; in other regions the rain descends only during a small number of days. In Great Britain and Ireland the number of rainy days varies from more than 250 in the north-west and western parts to 150 in some of the eastern districts. In some of the Continental districts, frequented by the invalid, the number of rainy days is under 60, thus permitting almost continuous out-door exercise, or, at least, exposure to the pure, open air. There are a great number of wet days in Ireland, which circumstance, however, has not been shown to injuriously affect the health of the people.

LECTURE IV.—ON VENTILATION.

The tissues of the animal body are composed chiefly of carbon, hydrogen, oxygen, and nitrogen. An animal tissue, let us say fat, is capable of being burned, and during its combustion, heat is evolved. We know that ordinary combustion only takes place through the intervention of atmospheric air. It is not every kind of combustion which evolves light and intense heat, as in the case of a burning jet of coal gas or a lighted taper. The air, or rather its oxygen, slowly burns the vegetable mould which covers part of the earth's surface; and the rusting of iron and other metals, and the decay of organic bodies, are simply cases of slow combustion or oxidation.

The animal body is slowly burned by the action of atmospheric oxygen. Every time we *inspire* we draw atmospheric air into the lungs, where its oxygen, dissolving in the blood, is carried from them throughout every part of the system. By means of the oxygen introduced in this way into the body, the tissues are burned, their hydrogen being converted into water, and their carbon into carbonic acid. In the act of *expiration* we throw out from the lungs the products of the decomposition of the tissues, namely, carbonic acid gas and watery vapor. I have already shown you that carbonic acid is a poisonous substance, and it is evident that if it were allowed to accumulate in the air of our dwellings it would seriously injure our health. Ventilation is the means by which carbonic acid gas and other matters, thrown off from our lungs and the surface of our bodies, are not allowed to exceed the proportions in which they exist in pure air.

The quantity of air breathed by an adult man is, on the average, 16½ cubic feet per hour. The air thrown

out from the lungs contains a large proportion of carbonic acid, and to lower its amount until it is only four parts in 10,000 (as in pure air) it is necessary to mix with 1 part of vitiated air 125 parts of pure air. You will perceive, then, that it is not sufficient to supply a man with the exact quantity of air which passes into his lungs, but with 125 times that quantity, or about 2,000 cubic feet per hour.

Sick persons require more air than do those in robust health. In diseases of an inflammatory character there is an abundant exhalation of organic matter, which, unless speedily oxidized, renders the atmosphere intolerable. A less supply than 3,500 cubic feet per hour is insufficient for a sick adult or even child. Gangrene, pyæmia (blood poisoning), small-pox, erysipelas, and typhus and puerperal fever taint the air to an extraordinary extent; and persons suffering from those diseases should be supplied with from 7,000 to 10,000 cubic feet per hour. In typhus and pyæmia almost complete exposure to the open air has been attended with the most favorable results. It is now generally acknowledged that persons suffering from phthisis are much benefited by remaining in the open air during the whole day, unless the weather be unfavorable.

General Morin, in a report to the French Government in 1860, gives the statements shown in the diagram.

Amount of Air required, per head, per hour, in Temperate Climates.

	Day.		Night.
In Barracks ...	1,059	Cubic Feet.	2,118
Workshops ...	2,118	„	
Prisons	ibid.		
Theatres	ibid.		
Hospitals	2,825	„	
Ibid, during dressing hours	4,236	„	4,236
Ibid, during epidemics	5,650	„	5,650

In British barracks the regulation allowance of air is 1,000 cubic feet per hour.

The effect produced on air by the combustion of candles, oil, gas, and fuel is nearly the same as that caused by respiration. One pound weight of oil consumes about 140 cubic feet of air. Every cubic foot of coal gas uses up the oxygen of from 14 to 15 cubic feet of air. An ordinary gas burner consumes nearly 45 cubic feet of air per hour, and, therefore, vitiates the atmosphere of a room to an extent nearly equal to that produced by the respiration of three men. In calculating the quantity of air to be supplied to rooms in which people are sleeping or working, the number of gas lights, candles, or lamps burning in them must be taken into account.

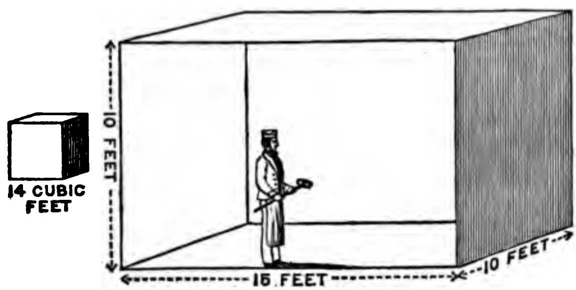
In the diagram are shown the amounts of carbonic acid produced by the combustion of various illuminating agents in such quantities during 10 hours as to evolve a light equal to that given by 20 sperm candles, each weighing 120 grains:—

	Cubic Feet of Carbonic Acid.
Tallow	10.1
Wax	8.3
Spermaceti	8.3
Sperm Oil	6.4
London Gas	5.0
Manchester Gas	4.0
Cannel Coal Gas	3.0
Boghead Coal Gas	2.6
Lesmahago Coal Gas	2.3

A rich coal gas, therefore, gives as much light, and but one-fourth the carbonic acid, as are evolved from tallow candles. I may here remark that tallow candles, in producing as much light as an equivalent amount of cannel coal gas, evolve twice as much heat.

The space allowed to each soldier in sleeping and other apartments is fixed by the military authorities at

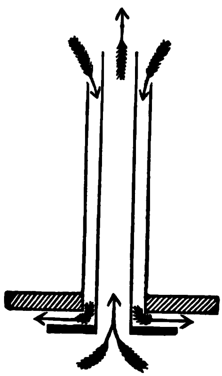
600 cubic feet in permanent barracks; 400 in huts; 600 in wooden and 1,200 in permanent hospitals at home, and 1,500 in the tropics. In the London lodging-houses the Legislature prescribes 30 superficial and 240 cubic feet per head. According to the poor law regulations, each person is allowed 300 cubic feet to sleep in; 500 if sick. In Dublin, 300 cubic feet per head is the minimum space permitted in the registered lodging-houses—9,000 in number. A room 10 feet high, 15 feet long, and 10 feet wide contains 1,500 cubic feet of air, and may, according to the Sanitary Act of 1866, accommodate 5 persons. The diagram shows the comparative size of a man and that of a room of the dimension which I have described. The cube shows the quantity of air which every hour passes into the lungs of one person, averaging both sexes and all ages.



The atmosphere of the largest room in which persons are living becomes vitiated, unless there are apertures of sufficient magnitude to admit fresh air and to allow the foul air to escape. In a sleeping apartment there should be an opening of 24 square inches to admit the fresh air required for one individual—adult or child; and as foul air is usually lighter than fresh, there should be an aperture 25 square inches in extent to allow it to pass out of the room.

It is often somewhat difficult to ventilate buildings without at the same time producing unpleasant draughts; but the thing is never actually impracticable. Rooms in private dwellings need never want for pure air if the least attention be bestowed on the arrangements for their ventilation.

The outlets for the vitiated air should be removed as far as possible from the inlets for the pure air; otherwise the circulation of the air throughout the apartment is not so perfect. In M'Kinnell's ventilator, however, the inlet and outlet are close together. This ventilator is intended to introduce the pure air through the ceiling. It consists of two tubes, one placed within the other. The inner is a little longer than the outer one, and through it the vitiated air escapes. The outer tube is that through which the pure air descends into the room; and the lower part of it being provided with a flange, the air at first spreads along the ceiling, and afterwards descends by the walls to the lowest part of the room.



M'KINNELL'S PATENT VENTILATOR.

Arnott's ventilator is simply an opening, provided with a valve, leading into the chimney. It is most useful for the purpose, but occasionally smoke from the chimney forces a passage through it into the room.

The air thrown off from the body and the gaseous products of combustion are very light, and rapidly ascend. It follows, therefore, that the vitiated air should pass out at the highest point of the apartment. The purer and heavier air should be admitted about eight feet above the floor. If the apartment is ventilated by heated air, then the openings for its admission

may be at or near the floor, but cold air flowing into a room at the lowest point occasions much discomfort, by cooling the feet, and in other ways. The air may be warmed by passing it through boxes heated by coils of pipes, through which a current of steam or of hot water flows; but under no circumstances should air from a furnace be admitted into rooms. An economical method of introducing pure warm air into a room is to construct the open fire-place or stove flue in such a way that the air heated by the outer surface may pass into the room. This system of simultaneously heating and ventilating apartments is likely to come into general use in private dwellings, for it has been found very successful in many hospital wards and barrack-rooms. Mr. Bashford, of Ely-place, heats and ventilates buildings on this principle.

Where gas is burned ventilation is easily effected by having an opening in the ceiling exactly over the gas lights, and a tin tube leading from it direct to the open air. The cost of the tube (which is placed between the ceiling of the room to be ventilated and the floor of the one above it) is seldom more than a pound, and in case of small apartments only a few shillings. When the tube is passed into the air it should not be carried up too high, otherwise down draughts might be produced. A second tube placed round that containing the heated products of the combustion of the gas will have its contents heated; and if an opening from it be made into the upper room, a large supply of pure, warm air may be economically obtained. If required, the outer tube may be made to discharge its contents into the room where the gas is burning. Perforated bricks are now very generally placed in the walls of houses. Iron frames covered with perforated zinc are good substitutes for the poros bricks; when provided with valves—to close them if necessary—they are very good ventilators. Mr. Louch, of this city, has devised an excellent ventilator. It con-

sists of a wooden box, containing three or four partitions of perforated zinc. The box is inserted obliquely in the wall near the ceiling, and the air passing through it is divided into numerous currents and directed towards the ceiling. I have seen this ventilator work very well, but it does not secure complete immunity from draughts.

In ventilating rooms, large or small, bear in mind that the warmer the outlets are the more rapid and perfect will be the passage of impure air through them; for, when their temperature is lowered to that of the external air, they are as likely to allow pure air to enter as they are to permit the foul air to escape.

The plans proposed for ventilating and heating churches, theatres, and other large buildings are almost innumerable. The Houses of Parliament are ventilated by means of air forced into them by powerful machinery. In summer, cold air, and in winter, warm air may be, by propulsion, introduced into large enclosed spaces. One advantage of this plan is that the air may be obtained from a great height above the level of the ground, where it is most likely to be free from organic impurities.

In ordinary rooms, the doors, windows, and fire-places act, or, at least, ought to be used, as ventilators. A sitting-room, with a good-sized aperture in the ceiling, an open fire-place, and an open door, seldom has an impure atmosphere.

In winter, the combustion of fuel produces a strong current of air up the chimney. Stoves are not nearly so useful for this purpose, as there is no wide, open space above the fuel. Two currents of air are always passing towards an open fire-place; one of them supplies oxygen to support the combustion of the fuel, and passes into the grate; the other rushes up the chimney without being consumed, and thereby drags, so to speak, a fresh supply of air into the room. In summer it is the fashion to close the registers of grates, and thereby prevent the

chimney from being useful as a ventilator. Instead of doing this foolish act, it would be better to render the chimney still more useful, by placing at the top of it one of Norton's Archimedean screw ventilators. This apparatus consists of a drum-shaped fan, attached to an Archimedean screw. The fan is so nicely arranged that the least current of air is sufficient to set it in motion; and as it rotates it turns round the screw attached to it, producing, so to speak, a spiral column of ascending air through the chimney. Norton's ventilator may also be employed instead of the perforated bricks or other contrivances for allowing the egress of foul air. In some institutions I have seen three sashes in each window—an admirable contrivance for either admitting air or allowing it to escape at different heights from the floor.

Wind is one of the best natural ventilators, not only in the case of open places, but even in our dwellings. Its velocity varies from a few feet to 110 miles per hour. Its pressure upon a square foot of surface ranges from less than an ounce to 50 pounds. A light breeze moves about 8 or 10 miles an hour, a moderate wind 18 miles, a gale 35 to 50 miles, a storm 60 to 75 miles, and a hurricane 80 to 110 miles. In these countries the average annual motion of the wind is about seven miles per hour. Every variation in the temperature of the air produces a wind: for example, in winter the higher temperature of the interior of a dwelling, as compared with the air outside of it, produces a wind, the direction of which is towards the house. The mode in which wind ventilates is easily explained: it rapidly carries off the organic matter and other impurities, and mixes them with the great bulk of the atmosphere, where they are either oxidized or rendered harmless by excessive dilution. When the wind is strong, it forces its way into houses even when the arrangements for ventilation are imperfect. It passes

even through brick walls, especially when they are old and dry, and, consequently, very porous. It forces its way through the smallest chink or flaw; and no door or window is so perfectly fitted in its case as effectually to exclude the admission of wind. What is called thorough, or through ventilation is, to allow the wind to blow freely right through a house. Moving at the rate of a mile an hour—a motion almost imperceptible—and allowed to pass freely through a room, it will renew the air in it 270 times per hour. The great advantage of keeping open every window in the house for a few hours daily is the admission of so large a quantity of air that the organic matter floating in the atmosphere of the apartments cannot escape oxidation. The excess of carbonic acid gas in a room can be got rid of by keeping the windows open for a few minutes; but the organic matter thrown off from animals requires prolonged exposure to pure air before its noxious properties are perfectly destroyed. The humbler classes appreciate so little the advantage of the value of abundance of pure air that they rarely take any measures to ventilate their sleeping apartments. It is, perhaps, fortunate for them that the imperfect carpentry of their dwellings usually prevents their attempts to utterly exclude the air.

It has been shown by chemists that if two vessels, each filled with a different gas, be allowed to communicate with each other, both will, after some time, be found to contain equal proportions of the two gases. Hydrogen gas is 22 times lighter than carbonic acid gas; yet, if a vessel filled with the heavier of these gases be placed *under* one containing the lighter, the hydrogen will instantly begin to descend, and the carbonic acid to ascend, and after a certain time equal proportions of the two gases will be found in both the lower and upper vessels. As no room is absolutely air tight, the gases contained in it diffuse themselves into the atmosphere, and gradually become replaced by fresh air derived

from the outside. It is owing to this property of the diffusibility of the gases that the air of a room is renewed, even when there is no wind; but it is not sufficient to maintain the atmosphere of a room pure, unless the openings are sufficiently large to permit the free interchange of the gases.

The amount of disease produced by breathing air containing abnormal amounts of carbonic acid, sulphuretted hydrogen, and organic matters is really fearful to contemplate, more especially when one reflects that it is nearly altogether the result of ignorance or carelessness. Sick headaches and nausea are the common results of breathing air which had repeatedly been respired; and rigors are sometimes produced under the same circumstances. The breathing of slightly vitiated air for even a few hours produces, says Dr. Parkes, increased temperature, quickened pulse, furred tongue, loss of appetite, and thirst, for even forty-eight hours afterwards. The continued respiration of the same quantity of air renders it at length a deadly poison. Every one has heard of the dreadful sufferings endured by a party of our countrymen, who, on the night of the 18th June, 1756, were immured in the notorious "Black Hole" of Calcutta, by order of Surajah Dowlah, Nabob of Bengal. They and their dependents—to the number of 146—were forced into a room only 18 feet square. The atmosphere of the confined place speedily became poisoned with carbonic acid and organic matter. An agonising scene lasted all night; and in the morning the bodies of 123 poor creatures lay breathless upon the floor. Of the few survivors, many died shortly afterwards, and most of the others lingered on miserably for a few years. After the battle of Austerlitz, 300 Austrian soldiers were, probably through ignorance, crowded into a small prison; in a very short time no fewer than 20 of those unfortunate men perished miserably. One of the most

recent cases of what I may term wholesale poisoning by means of vitiated air occurred on board the steamer *Londonderry*, in the year 1848. This vessel was on a voyage from Sligo to Liverpool when, a storm coming on, the captain confined 200 passengers below the hatches, which he battened down and covered with a tarpaulin. The space in which the poor people were crowded allowed to each person but 7 cubic feet of air—300 feet being, as I have explained, the minimum quantity allowed to each person in the dormitories of the workhouse. Imagination fails to realize the horrors of the living tomb into which these persons were forced, and in which nearly 100 of their number laid down their lives—poor victims sacrificed on the altar of ignorance!

The number of deaths caused by breathing vitiated air cannot, of course, be accurately ascertained, but it is unquestionably very great. Pulmonary consumption is a common result of breathing the air of close rooms. Before barracks were so well ventilated as they now are, the number of deaths from phthisis was much greater than it is at present. That impure air produces scrofula was shown many years ago by Dr. Carmichael, and since his time by many other observers. Many other maladies of a more or less serious character are the products of the respiration of vitiated air; and if not the direct cause of some diseases, it is often a contributary to, or aggravator of, them.

It has been my sole aim throughout this lecture to impress upon you as forcibly as I could the paramount necessity for supplying abundance of pure air to the interior of our houses. If you desire long life and good health, recollect that you cannot have, or at least are not likely to have, either if you habitually breathe in an impure atmosphere. I have shown you that every unit of the population vitiates nearly 2,000 cubic feet of air per hour. Each person requires 500 cubic feet of space to sleep in, and 50 square inches of apertures to allow

fresh air to come in and foul air to escape. Examine the conditions of your dwellings and satisfy yourselves that these indispensable provisions for the maintenance of health and strength are present.

LECTURE V.—ON EXHALATIONS FROM MANUFACTORIES, WORKSHOPS, AND CHIMNEYS.

In the manufacture of various articles, and by the combustion of fuel, large quantities of gases, vapors, and solid particles of matter are discharged into the atmosphere. These matters are often evolved in such enormous quantities as to render the atmosphere impure; and they are one of the many causes to which the comparative unhealthiness of towns is ascribed.

In Dublin, unfortunately, perhaps, for its citizens, but few of the great industries of these countries flourish. We have, consequently, much less reason to complain of the vitiation of our atmosphere by exhalations from factories than have the citizens of Manchester, Birmingham, Sheffield, Glasgow, and most of the other large towns of Great Britain. But Dublin is far from being free from atmospheric impurities derived from chemical works, smoky chimneys, and similar sources: it is, however, some consolation to know that they do not injure our health to the same extent as in the case of most of the towns on the other side of the Channel.

The gases and vapors which escape from chemical works are chiefly sulphurous acid, sulphuric acid,

muriatic acid, and chlorine. When these gases and vapors constitute a sensible proportion of the air, they act injuriously on the respiratory organs, producing, in extreme cases, bronchitis and inflammation of the lungs. The well-known substance, carbonate of soda, is manufactured upon a large scale in England and Scotland. The first step in the process is to convert common salt into sulphate of soda, or salt cake. This is accomplished by treating the salt with sulphuric acid—the products of the re-action are sulphate of soda and muriatic, or hydrochloric acid gas. In the alkali works—as the soda manufactories are termed—the muriatic acid, being incidentally produced in larger quantity than is required, was formerly permitted to escape into the air, and often in such quantities as to injuriously affect both animal and vegetable life. The Alkali Nuisance Prevention Act, passed in 1864, compels the soda and salt cake manufacturers to prevent the escape of at least 95 per cent. of the muriatic acid produced in their works. The head inspector of alkali works is Dr. Angus Smith, of Manchester—a very distinguished chemist—and he is aided by several competent assistants. These gentlemen periodically inspect all the alkali works in these countries, and report annually to parliament upon the subject. It would appear from their last report that in the four alkali works situated in Dublin there is no escape of muriatic acid through the chimneys. In other parts of the United Kingdom the amount of gas escaping varies from 5 to 0 per cent.

In Dublin very little gaseous matters from the chemical works escape into the air, owing to the excellent manner in which the various kinds of apparatus used in them are constructed and maintained. In justice to the proprietors of these works, I should mention that they have adopted—and at considerable expense—the numerous suggestions for the prevention of the escape of gases and vapors made to them by Dr. Mapother and myself.

Various salts of ammonia are manufactured from a liquid obtained from coal gas works: it contains tarry matters, creosote, and compounds of ammonia with carbonic acid and sulphuretted hydrogen. On pouring sulphuric or muriatic acid into this liquid, the carbonic acid and sulphuretted hydrogen gases are expelled, the stronger acid taking their place. As this operation is conducted upon a very large scale, immense volumes of sulphuretted hydrogen are often daily discharged into the air from the "ammonia works." There is but one ammonia manufactory in Dublin, and from it large quantities of sulphuretted hydrogen were constantly for many years allowed to pass into the atmosphere. In 1866 Dr. Mapother and myself suggested a remedy for this serious evil, which was simply to treat the gas liquor in close vessels, and cause the gaseous matters evolved from it to pass through a furnace before entering the chimney of the works. Sulphuretted hydrogen gas being combustible, is completely decomposed at a high temperature. Many of the noxious volatile bodies thrown off during various manufacturing processes might be rendered harmless or less injurious if passed through burning fuel.

Chlorine and sulphurous acid are powerful disinfectants, and unless evolved in such quantities as to act corrosively upon the tissue of the lungs, they are useful additions to an atmosphere containing sulphuretted hydrogen and organic matter. In Dublin, and in many other cities, the coal gas and chemical works are situated in the same quarter; their exhalations, therefore, neutralize each other, and produce comparatively innocuous bodies.

In reducing copper and lead from their ores, sulphurous acid, sulphuric acid, arsenic, and even lead, are volatilized. I have detected lead in plants grown near the lead smelting works at Ballycorus, County of Dublin; and sulphurous and sulphuric acids from copper

smelting works in England have been known to injure large tracts of vegetation. Herbage affected with sulphurous acid often produces disease in the animals fed upon it.

Tar and creosote works evolve the vapors of various hydro-carbons; but these bodies, though rather unpleasant to smell, are not dangerous to health, unless breathed in much larger quantities than they ever occur in the atmosphere.

In works where illuminating gas is manufactured it is difficult—owing to the magnitude of the operations—to prevent noxious gases and vapors from escaping into the atmosphere. Coal is the raw material employed, and it is heated to redness in close vessels, whereby it is resolved into a variety of substances—solid, liquid, and gaseous. The solid product is coke, which remains in the vessels, or *retorts*, as they are called; the liquids consist of a great variety of substances, resembling naphtha; the gases are—hydrogen, light and heavy carburetted hydrogen, carbonic acid, carbonic oxide, nitrogen, sulphurous acid, sulphuretted hydrogen, ammonia, and prussic acid; the vapors are bisulphide of carbon and various volatile compounds of hydrogen and carbon, resembling naphtha. Owing to leaks in the various parts of the apparatus, small quantities of all these volatile bodies constantly escape into the air, even from the best managed works; it would, therefore, be desirable when building gas works to select a site in a thinly populated place, and as far from the town as possible.

When the gases and vapors issue from the retorts they are subjected to the action of water and lime. The tarry liquid, nearly all the ammonia, and some of the sulphurous and carbonic acids, and sulphuretted hydrogen, are retained by the water. The lime takes up the rest of the sulphurous acid, sulphuretted hydrogen, and carbonic acid, and the traces of prussic acid which escape solution. The gases that remain

pass into the "gas holders," and from thence to the points at which they are consumed for illuminating and heating purposes. Unless great care is taken in purifying the gas before it is delivered to the consumers, it is certain to contain sulphuretted hydrogen and ammonia. Impure gas is most injurious to the health of inmates of rooms where it is burnt. It is satisfactory to learn that the Corporation inspector of gas reports that sulphuretted hydrogen is never present in the gas supplied to Dublin. Ammonia is never absent; but in minute quantities it cannot be regarded as an injurious impurity. Bisulphide of carbon is a most objectionable impurity, and is invariably present. When burned, it produces sulphuric acid, which acts corrosively on the leather binding of books and on many other articles. A process for removing bisulphide of carbon from coal gas has recently been successfully tried, and I hope it may be employed in this city. An Act of Parliament limits the amount of sulphur in coal gas to 20 grains per 100 cubic feet of gas.

The lime used in purifying coal gas is often a nuisance of great magnitude. It is usually allowed to remain for a considerable time in large quantities exposed to the atmosphere—into which it abundantly exhales sulphuretted hydrogen gas. In Dublin the *waste lime* of the gas works was formerly employed as an ingredient of the *luting*, or cement, plastered over the joints of the retorts; of course, the high temperature of these vessels drove off a large proportion of the sulphuretted hydrogen from the lime. Owing to the interference of Dr. Mapother and myself, the nuisance arising from the waste lime process has been abated in the Dublin gas works; oxide of iron is now being substituted for lime, and will purify the gas as effectually. Moist oxide of iron and sulphuretted hydrogen produce water and sulphide of iron—two inodorous substances. The oxide, mixed with sawdust, is placed in layers 10 or 12 inches deep

on perforated trays or shelves, through which the gas passes. So soon as the absorption of sulphuretted hydrogen gas is complete, the sulphide (into which the oxide has been converted) is exposed to a current of air, which reproduces the oxide, and sets free the sulphur. This purifier can, therefore, be repeatedly used until it becomes mixed with too much sulphur; even then it is valuable to the sulphuric acid manufacturer. The drainage from gas works should never be allowed to mix with sewage from chemical works; the acid contained in the one setting free the sulphuretted hydrogen and prussic acid dissolved in the other. I found such a mixture flowing through sewers into which the drainage from the gas works and some of the chemical works of Dublin was discharged: the drainage from the chemical works is now poured directly into the Liffey.

Coke works and lime kilns discharge enormous quantities of carbonic acid and carbonic oxide into the air. They should not be tolerated within the limits of towns. There are more than a dozen lime burners and one coke maker in Dublin. Carbonic acid, carbonic oxide, and traces of sulphuretted hydrogen gas are given off during the manufacture of bricks and cements.

Artificial manure works in general throw out sulphurous acid gas. Sometimes the odor of decomposing animal matter is very perceptible at and near these works; but in general they do not affect the atmosphere to a greater extent than alkali works.

Slaughter-houses are amongst the greatest nuisances from which the inhabitants of towns suffer. They are, with few exceptions, mean, dark, ill-ventilated, and badly kept buildings. Their walls are occasionally whitewashed, and their floors washed; but being roughly paved, the decomposing animal matter is never perfectly dislodged from the crevices and deep fissures of their floors. The atmosphere of those places is highly tainted with putrescent matters evolved from the blood

and other portions of the slaughtered animals; and I am quite satisfied that the slaughter-houses of Dublin—nearly 100 in number—seriously affect the public health. An effectual remedy for this nuisance would be the establishment of abattoirs under control of the Corporation.

Bone boiling, tallow melting, and glue-making are processes from which are evolved vapors of no very pleasant odor. If the nuisance be very sensible, it admits of a remedy either by an action at common law or by the interference of the Public Health Authority.

The air of towns is tainted with the products of the combustion of fuel. Carbon constitutes the great bulk of ordinary fuel: at a high temperature it unites with atmospheric oxygen, and produces carbonic acid. The quantity of heat evolved during combustion is proportionate to the amount of oxygen consumed by the fuel. Carbon unites with oxygen in two proportions, forming carbonic acid and carbonic oxide: the centesimal composition of these compounds is shown in the diagram:—

	Oxygen, Per cent. by weight.	Carbon. Per cent. by weight.		
Carbonic oxide	... 57.14	42.86	=	100.
Carbonic acid	... 72.72	27.28	=	100.

Carbonic acid is carbon in a perfectly oxidized, or mineral state; but carbonic oxide is a highly combustible body. Eighty parts of carbonic oxide produce as much heat by combustion as 26 parts of carbon. It is evident, then, that, in order to obtain the maximum amount of heat from our fuel, we must convert the carbon into carbonic acid. Owing, however, to the defective construction of furnaces, a large quantity of the fuel used in manufactories is lost, because its carbon is converted into carbonic oxide. The pale flame which you sometimes see emerging from high chimneys is produced by highly heated carbonic oxide, combining with the atmospheric oxygen.

Limited oxidation is the cause of the evolution of carbonic oxide from furnaces, stoves, and fire-grates. Sometimes the carbon of the fuel is at once converted into carbonic oxide; at other times carbonic acid, formed where the air is abundantly supplied to the fuel, is afterwards converted into carbonic oxide by contact with red hot but *not* burning carbon. The greater part of the fuel in furnaces is in a state of incandescence, but not of combustion; it is so highly heated by the burning part of the fuel as to evolve light. Carbonic acid gas passed over incandescent charcoal combines with it and forms carbonic oxide; and in this way the products of the perfect oxidation of one part of the fuel carry off, imperfectly oxidized, another portion of it.

The imperfect oxidation of fuel produces two bad results—firstly, a waste of heat; secondly, the vitiation of the air. Carbonic oxide is a highly poisonous compound—far more so than carbonic acid; and, as it does not contribute to the growth of plants, its presence in the atmosphere subserves no useful purpose. I am at a loss to account for all the tons of carbonic oxide which are thrown into the air; probably this gas is gradually converted into carbonic acid.

The cause that produces carbonic oxide in furnaces also gives rise to smoke from them. On an average, nearly one per cent. of coal passes off in the form of soot—a mixture of tar, charcoal, coal ashes, and a few other substances. Smoke, hanging like a pall over a town, acts injuriously by partially excluding light; and air containing sooty particles is likely to affect the respiratory organs. Whether or not the more serious affections of the pulmonary organs are produced by the respiration of smoky air, exact evidence is wanted to determine.

The evolution of smoke and the production of carbonic oxide might be considerably lessened by careful stoking. If too much air be admitted, the temperature

of the fire is lowered below the point of perfect combustion; but the great and usual defect is a deficiency of air. Coal contains carbon and hydrogen, and when highly heated yields carburetted hydrogen gas. When a fire is lighted, coal gas begins to be produced, and the hydrogen of it, being the more combustible body, is first oxidized. The carbon separated from the hydrogen is then, if there be abundance of air, also burned; but if the supply of oxygen be inadequate, part of it is converted either into carbonic oxide or smoke, or both. To prevent smoke, the fire should be maintained at a high and nearly equable temperature, so that the gases may not be cooled. The fuel should be added frequently and in small quantities and pieces, and care must be taken not to choke the furnace. Fresh fuel should be placed at the door of the furnace, the red coal being pushed back. A common mistake is to do exactly the reverse, whereby the fresh coal is, to a great extent, converted into unoxidized gases, which escape up the chimney. The openings through which air is admitted to all places where fuel is burned should be kept free from ashes.

There are several kinds of furnaces which are said to emit no smoke, but I believe the best of them permit unoxidized matters to escape. Juckes's chain furnace is very costly, but it certainly effects great economy of fuel. The fire bars consist of a series of "endless" chains set in motion by means of two wheels furnished with teeth. A hopper is placed in front of the furnace, and from it the fuel is delivered through an opening, the size of which regulates the supply of fuel to the furnace. By these means the supply of fuel is regular, and every part of it is equably exposed to the air. Hill's furnace is intended to prevent smoke, by mixing highly-heated air with the unburnt gases as they pass from the furnace to the flue. Prideaux's smoke prevention furnace is mentioned favorably by several authori-

ties on this subject. The 108th section of the Towns Improvement Clauses Act (1847) enables municipal authorities to prosecute those who permit smoke to escape from the chimneys of manufactories.

As even in open fire-places coal is never burned completely, gaseous matters from it escape into our apartments. Silver is tarnished by sulphuretted hydrogen: the yellow color which plate acquires when exposed to the air is due to the sulphide of silver formed on its surface, chiefly by the sulphuretted hydrogen from burning coal. It would add greatly to our health and comfort if we could succeed in preventing the products of the combustion of coal gas, and even of oil and candles, from mixing with the air which we breathe.

The products of combustion discharged into the atmosphere are got rid of by *diffusion* and the winds. Their frequent presence to an abnormal extent in the air of towns has, however, been demonstrated by Angus Smith, Da Luna, and other observers.

LECTURE VI.—ON FOOD AND DIET.

A GREAT variety of substances constitute the world, or at least that part of it exposed to the view of man; but they are all resolvable into a very small number of bodies. Chalk is termed by chemists a compound body, because it can be decomposed, and various other matters extracted from it. On analysing chalk it is converted into a solid substance termed lime and a gaseous matter known as carbonic acid. In the same way, lime may be resolved into a metal called calcium, and the well-known oxygen gas; whilst carbonic acid yields carbon, or charcoal, and oxygen gas. Chalk is, therefore, proximately composed of lime and carbonic acid, and ultimately of calcium, carbon, and oxygen. The process of analysis ends when the ultimate elements of compounds are reached. Oxygen, calcium, and carbon cannot be analysed; they resist all attempts to decompose them—that is, to extract any other kind of matter from them—and hence they are termed simple bodies, elements, or ultimate principles of matter. About 66 of these elements are known; but the progress of enlightenment may show that some bodies now believed to be simple are in reality compound, and reveal to us the existence of simple bodies which have not yet met the eye of man.

Of the 66 elements, more than one-half occur in such minute quantities, comparatively speaking, that the most profound philosopher has been unable to determine their functions in the economy of creation; and even the larger number of the remaining elements constitute but a small proportion of the earth's surface. The ocean, the atmosphere, nine-tenths of the weight of the crust of the globe, and all animal and vegetable sub-

stances, are made up of little more than a dozen elements. Excepting aluminium, all the more abundant elements occur in animals and vegetables, and are, therefore, food principles. Those elements are—Carbon, Oxygen, Hydrogen, Nitrogen, Sulphur, Phosphorus, Chlorine, Iodine, Bromine, Silicon, Potassium, Sodium, Calcium, Magnesium, and Iron. Iodine and Bromine are only found in plants that grow at the sea coast, and in a few low forms of animal life. Fluorine, Manganese, Aluminium, Lithium, Cæsium, Rubidium, and even Lead, Copper, and Arsenic, have been found in plants; but I believe their presence in vegetables and animals to be merely the result of accident.

It is the function of plants to organise mineral matter into structures of a most complex character, of which some are consumed as food by animals. A plant cannot grow in darkness, except at the expense of another plant; but when exposed to the stimulus of the solar beams, it absorbs from the atmosphere and the soil, carbonic acid, water, ammonia, and a little earthy and saline matter, and converts them into woody fibre, starch, gum, and various other organic matters. The more important functions of animals and plants are shown in the diagram:—

	PLANTS.		ANIMALS.
Convert	Carbon Hydrogen Oxygen Nitrogen	Reorganize	Carbon Hydrogen Oxygen Nitrogen
From their mineral condition of	Water, Carbonic Acid Gas, and Ammonia	From the condition of vegetable substances.	To the state of animal substance—albumin, fat, &c.,
To the organic condition of	Vegetable substances, such as fibre, starch, gum, sugar, oil, wax, &c.	And then disorganise and reduce them to their original condition of	Water, carbonic acid gas, and ammonia (or its equivalent, urea).

They absorb and decompose water and carbonic acid gas, and evolve oxygen. They accumulate force during life. They *are stationary.*

They inhale oxygen, and evolve water and carbonic acid. They incessantly evolve force. They have locomotive powers.

Whilst plants are wholly independent of animals, the most insignificant, as well as the most highly organised, animals are directly or indirectly dependent upon plants. In the vegetable mechanism minerals are converted into organic substances, during which process much force or motive power, derived from the solar beams, is expended. Vegetable substances are, therefore, reservoirs of force; and when they are disorganised in the bodies of animals, all the force expended on their production is set free, and becomes recognisable as animal heat and motive power. The greater the quantity of force stored up in food, the more valuable it is; and if two kinds of nutriment be equally digestible, that which evolves by combustion the more heat or force is the more valuable.

According to Prout, the food of man should embrace four classes of aliments—namely, the *aqueous*, the *albuminous*, or *nitrogenous*, the *saccharine*, and the *oleaginous*; to which he should have added the *saline*.

Water, alcohol, and vinegar constitute all the important bodies belonging to the aqueous group. The physiological action of alcohol is not yet accurately determined; but water is an indispensable fluid to animals, and cannot be replaced by any other liquid. The nitrogenous substances nourish the muscles, brains, nerves, and the organic portion of the bones. Albumin, fibrin, casein, and gelatin are the most important members of this group. The oleaginous substances comprise the fats and oils. They constitute a particular tissue—termed the *adipose*—of the animal body, and they are generally distributed throughout the muscles, brain, nerves, and even the skin. The saccharine group comprises not merely the sugars, but also starch, gum, pectin, and several other substances. The saline elements of nutrition embrace the substances which remain when animal and vegetable bodies are subjected to complete combustion. Phosphoric and sulphuric acids, chlorine, potash, soda, lime,

magnesia, and a little iron, are the only importan saline ingredients of food. The saccharine, oleaginous and aqueous foods cannot be converted into members of the albuminous group; but nitrogenous substances ar capable of forming fat. There is the clearest evidenc that in the animal economy, sugar, starch, and pecti are converted into fat.

According to Liebig the functions of food are tw fold. They repair the worn-out tissues of the anim frame, and they maintain, by slow combustion, the nece sary temperature of the body. The foods which for tissue he terms *flesh formers*, or *plastic nutritive materia* —they consist exclusively of matters containing nitroge the substances which maintain animal heat he tern *respiratory* materials, or *heat givers*—they embrace th fats, sugars, starches, alcohol, and all other non-nitr genous foods, except the saline. The force develope by animals is derived, says Liebig, from the oxidatic of their nitrogenous tissues, and not from the combustic of any other constituents of their bodies.

The carbo-hydrates include the most abundant co stituents of vegetable food, namely—starch, gum, suga and pectin. Starch constitutes from 55 to 82 per cen of the weight of cereal grains, four-fifths of the nutriti portion of the potato, and a large proportion of the di matter found in most seeds, tubers, and roots. Arrov root, tapioca, and tous-le-mois are simply pure forms starch.

Gum occurs abundantly in vegetables; there a several varieties of it, of which the greater number appe to be indigestible, and perhaps all are so.

There are at least a dozen kinds of sugar. Th variety termed cane sugar, or *sucrose*, exists largely in th sugar cane, the beet, carrot, pumpkin, and various oth plants. It is the kind commonly used in these cou tries. Grape sugar is found in fruits and honey. Wh corn is malted the starch which it contains is, to a gre

extent, converted into grape sugar. In sweetening power $2\frac{1}{2}$ parts of grape or starch sugar are only equal to one part of cane sugar, but the nutritive power of the two varieties I believe to be equal.

Pectin, or vegetable jelly, is the substance which causes the juice of many roots and fruits to gelatinise. It is a rather abundant constituent of the fruits, roots, and foliage of plants, and is a nutritious substance.

It is not probable that there is any important difference between the alimental value of the starches, sugars, and pectin. They are composed of but three elements—oxygen, hydrogen, and carbon—combined in about the same proportions. Alone they cannot support animal life, but as ingredients of food they enter more largely than any other class of aliments into the dietaries of man. Oils and fats occur abundantly in the seeds of certain vegetables, more especially those belonging to the cruciferous family, such as, for example, the rape and cabbage. In some seeds—for example, those of the cereals—they exist but in very minute quantities. These substances are composed of the elements which form the sugars and starches, but they contain much more carbon and hydrogen, and, consequently, less oxygen. They evolve more heat when burned, and there is reason to believe that, in nutritive power, 1 part of oil or fat is at least equal to $2\frac{1}{2}$ parts of sugar, pectin, or starch.

The fat and oil obtained from animals are often perfectly identical with those derived from plants; and it is probable that there exists but little difference between the alimental values of animal and vegetable fats.

The albuminous substances contain, in addition to the elements found in starch, nitrogen and a little sulphur and phosphorus. Albumin is an uncrystallizable body, soluble in water, until heated to 149 degrees, at which temperature it begins to coagulate; that is, to become insoluble. The gluten, or viscous part, of the

flour of wheat and other cereals is chiefly compo albumin and closely allied bodies.

Fibrin, when dried, is a tough, yellow, horn-lik stance. It is not nearly so abundant in plants as min. In the seeds of peas, beans, and of a few kinds of plants, a substance termed legumin is abundant. It is white, dissolves readily in col not in hot, water.

Albumin, fibrin, and casein are either identi nearly so in composition. It is probable that animal economy they are equally useful.

Albumin and fibrin are constituents of animal are probably derived, with but little, if any, alterat composition, from vegetables. Casein, the chee nitrogenous constituent of milk, differs in no ess respect from the legumin of the vegetable kin Widely, indeed, as animals and plants depart from other in form and attributes, there is but little diffe between many of their proximate chemical constitu

Centesimal Composition of Vegetable Foods.

	Water.	Flesh Formers.	Starch, Fat, &c.	Woody Fibre.	M
Cabbage ...	89.42	1.50	7.09	1.14	
Greystone Turnips	94.12	.74	2.56	1.85	
Aberdeen „	90.58	1.80	4.62	2.35	
White Globe „	90.43	1.14	5.46	2.34	
Swedish „	89.46	1.44	5.94	2.54	
Radish ...	95.09	0.52	1.06	2.22	[illegible]
Carrot ...	88.50	0.60	6.18	4.00	[illegible]
Parsnip ...	82.00	1.30	7.75	8.00	[illegible]
White Beet ...	83.00	2.50	11.50	2.00	[illegible]
Jerusalem artichoke	76.50	1.00	20.00	1.30	[illegible]
Potatoes, Regents	76.32	2.37	14.96	5.53	
„ Flukes	74.41	2.18	15.44	6.71	
„ Skerry Blues	76.60	2.06	14.89	5.41	
Wheat Grain ...	15.00	12.00	68.50	2.75	[illegible]
„ Flour ...	14.00	11.00	73.50	0.70	
„ Bran ...	13.00	14.00	55.00	12.00	[illegible]
Barley ...	16.00	10.50	67.00	3.50	[illegible]
Oats	14.00	11.50	64.50	7.00	[illegible]

	Water.	Flesh Formers.	Starch, Fat, &c.	Woody Fibre.	Mineral Matter.
Oatmeal ...	13.00	16.00	68.00	1.75	1.25
Indian Corn ..	14.50	10.00	69.00	5.00	1.50
Rye	16.00	9.00	66.00	8.00	1.00
Buck Wheat ...	14.19	8.58	51.91	23.12	2.20
Bere	14.25	10.00	64.50	9.03	2.03
Rice	14.00	5.30	78.50	2.50	1.50
Beans ..	13.00	25.50	48.50	10.00	3.00
Peas	14.00	23.50	50.00	10.00	2.50
Lentils ..	13.00	24.00	50.50	10.00	2.50

The flesh of animals is very concentrated aliment, and, with few exceptions, the health and strength of men are better maintained on a mixed animal and vegetable diet than on a purely vegetable regimen.

Flesh consists of muscle (lean flesh) and fat. Its red color is due to a rather large proportion of blood contained in minute vessels. There are several acids in flesh, which give it a very faint sour flavor. The agreeable odor evolved during the cooking of meat is produced by a complex substance termed *osmazome*, the amount of which varies according to the kind of flesh, and is one of the causes of the differences in the flavor and odor of meats. The albumin of the muscles, and the fatty and saline matters present in them, are digestible; but it is probable that the elastic muscular fibres, and the horny tissue which binds them into bundles, possess but little, if any, nutritive power.

Young meat contains more albumin and less fibrin and fat than are found in the flesh of the mature animal. Osmazome abounds in the flesh of game, and hence the superiority of the flavor of wild duck over the tame variety of that bird. The digestibility of veal and lamb is less than that of beef and mutton; but the strong smelling *hircic* acid which renders the flesh of the goat almost uneatable is not present in the well-flavored meat of the kid. The habits of animals exercise an influence on the quality of their flesh. Exercise, by increasing the amount of osmazome, renders their meat more savory. The

fatty, white mutton which we find most abundant in our markets is the produce of animals rapidly fattened and forced into premature development. Very different is the rich, brown meat furnished by the upland sheep of Wales and Wicklow—animals which, skipping from crag to crag, and subsisting exclusively upon the sweetest herbage, develop firm muscles replete with osmazome. The meat of sheep early brought to maturity contains not only an abnormal proportion of fat, but also an excessive amount of water—as the cook often discovers when she finds the huge leg of mutton reduced by cooking to an extent beyond her calculations.

The composition of flesh varies much with respect to the relative amounts of its nitrogenous and fatty constituents. Fat pork often contains five times as much fat as of lean flesh; whilst in a specimen of "jerked" beef imported from Monte Video I found only 5 per cent. of fat.

Centesimal Composition of Animal Carcasses, exclusive of Offal.

(According to Lawes and Gilbert's analyses.)

	Water.	Lean Flesh.	Fat.	Salts.
Fat Calf ...	62.3	16.6	16.6	4.48
Half-fat Ox ...	54.0	17.8	22.6	5.56
Fat Ox ...	45.6	15.	34.8	4.56
Fat Lamb ...	48.6	10.9	36.9	3.63
Store Sheep ...	57.3	14.5	23.8	4.36
Half-fat do. ...	49.7	14.9	31.3	4.13
Fat do. ...	39.7	11.5	45.4	3.45
Very fat do. ...	33.	9.1	55.1	2.77
Store Pig ...	55.3	14.	28.1	2.57
Fat Pig ...	38.6	10.5	49.5	1.40

Three samples of "corned" beef, prepared in South America according to Dr. Morgan's process—injecting brine into the carcass—were submitted to me for analysis, and I found them to contain on the average—

Water	40 per cent.
Fatty matters	21 "
Lean flesh	27 "
Mineral matters (chiefly common salt) ...	12 "
	100

Milk contains all the elements of nutrition: it is designed by nature as the appropriate food of the young, but in advanced life it is often found indigestible. Cow's milk contains, on the average, 87 parts of water, 3.25 parts of butter, 4.48 parts of cheese, 4.67 parts of a peculiar kind of sugar, and .60 parts of saline substances. Butter, if quite pure, consists solely of fatty matters, and is, therefore, incapable of forming muscle, nerve, or bone; the composition of the commercial article varies, but it is generally a mixture of 83 parts of butter, 3 of cheese, 9 of water, and 4 of salt.

Cheese, like butter, varies in composition, but on an average it contains 36 parts of water, 36 of casein, 24 of fats (butter), and 4 of saline matter.

Eggs contain 75 per cent. of water, 14 per cent. of albuminous matter, 11½ per cent. of fats, and 2½ per cent. of salts.

Analyses of Cooked Food.

	Water.	Flesh Formers.	Fats.	Starch.	Ash.
Meat (average quality)	54	27.6	45	1.5	2.95
Wheaten bread of average quality	40	8	1.5	49.2	1.3
Biscuit	8	15.6	1.3	73.4	1.7

The relative proportions of the constituents of the body of man vary. His average composition is, with tolerable accuracy, shown in the diagram.

Centesimal Composition of Man.

Water	72.00
Fat	9.25
Gelatin	10.00
Albumin	3.00
Fibrin, &c.	3.00
* Earthy and alkaline salts and a little iron	2.75
	100.00

* Potash, soda, lime, magnesia, chlorine, sulphuric acid, phosphoric acid, and oxide of iron.

These constituents of man are being incessantly disorganised, converted into mineral substances or semi-organised bodies, and finally ejected from the system. Every day a working man loses in this way about 5 per cent. of his weight, which he replaces in the form of food. According to Moleschott, a working man, of average height and weight, requires daily—

	Ounces, Avoirdupois.
Albuminous, or flesh-forming substances	4.587
Fatty bodies	2.964
Carbo-hydrates (starch, sugar, &c.) ...	14.257
Salts	1.048
	22.866
Water	98.580
	121.446

According to Lyon Playfair, 3 oz. of flesh-formers, ½ oz. of fat, and 12 ozs. of carbo-hydrates are the minimum quantities on which an adult can exist; but a working man will require three times as much flesh-formers, 2½ times as much fat, and 8-10ths as much carbo-hydrates.

From a careful consideration of the subject of diets, I have come to the conclusion that an adult man requires, per 100 pounds of his weight—

	Ounces.	
Flesh-formers	1½	
Fat	¼	
Starch, or other Carbo-hydrate	9	
Salts	½	
		11¼

When the amount of food is insufficient to supply these quantities, starvation ensues.

Dr. Playfair has calculated the diet of the British soldier to be—

	Ounces.
Flesh-formers	4.250
Fat	1.665
Carbo-hydrates	18.541
Mineral matter	.789
Total	25.245

According to Dr. Parkes, the French soldier receives 4.31 ounces of flesh-formers, 1.328 of fat, and 18.212 of starch, sugar, and other carbo-hydrates.

The diet of the British soldier on home service consists of:—Meat, 12 ozs.; bread, 24 ozs.; potatoes, 16 ozs.; other vegetables, 8 ozs.; coffee, .33 ozs.; tea, .16 ozs.; sugar, 1.33 ozs.; milk, 3.25 ozs.; salt, .25 ozs.: total, 65.32 ounces; costing, according to the state of the markets, from 7d. to 9d. Military prisoners at hard labor receive from 8 to 10 ozs. of oatmeal, 9 to 12 ozs. of Indian meal, 8 ozs. of bread, and 24 ozs. of milk.

In the civil prisons of Ireland the allowance for male adults consists of:—Meal, 8 ozs.; bread, 14 ozs.; milk, 1½ pints. In the excellent report on the dietaries of Irish gaols, lately presented to the Lord Lieutenant by Drs. Stokes, Hill, and Burke, several important alterations in the diet of the prisoners are proposed, which I have no doubt will be adopted by the authorities. They suggest that the day's allowance should be divided into three meals, instead of two, as at present; and that the diet for adult men should consist of:—Meal, 9 ozs.; bread, 6 ozs.; potatoes, 3½ lbs.; milk, 1½ pints; tea, 1 pint: on Wednesday and Friday, half a pint of milk to be substituted for the tea; on Sundays and Thursdays, a pint of meat soup and 14 ozs. of bread to be substituted for 3½ lbs. of potatoes and 1 pint of milk; and on Wednesday and Friday, the potatoes and 1 pint of milk to be replaced by 14 ozs. of bread and 1 pint of vegetable soup.

It is the belief of many physiologists that the dietaries of soldiers are defective: if such be really the case, those of prisoners must be more so. As for the inmates of the workhouses, they are less liberally provided with food than the criminals confined in gaols. At present the daily food of a soldier costs at least 8d., whilst in some of the Irish workhouses the nutriment supplied to a healthy male adult costs less than 3d. In one Union the daily cost of maintaining women is exactly 2d. each, the male adult consuming 2s. 4d. worth of food weekly. The guardians of the Dundalk Union appear to be amongst the most liberal in their expenditure; yet the cost of feeding an adult male in their workhouse is only 2s. weekly. The diet in this institution is stated to consist of "stirabout and milk, or bread and tea; potatoes and herrings, or eggs; occasionally fried bacon." The tax-payers often grumble when they are called on to pay a high poor-rate; but if they reflected for a moment upon their own happier lot, as contrasted with the wretched social condition of the pauper, they would hardly grudge paying for the miserable fare which barely serves to keep his body and soul together.

That there is an intimate connection between the *mind* that governs the body and the *matter* that nourishes the "dome of thought" is an opinion as old as the time of Aristotle. We know but little of the *cuisine* of the classic Greeks, for only a few descriptions of their cooked dishes—including that curious compound of eggs, cheese, and garlic termed *Mattuton*—have come down to us; but that they believed the passions of man could be developed or stimulated by particular kinds of food is clearly indicated by that peculiar institution of Sparta, the "black broth of war." This is the concoction which stimulated the Spartan to deeds of valor, and which caused a Sybarite who partook of it to exclaim, "Now do I perceive why it is that Spartan soldiers encounter death so joyfully."

Within the last two centuries many authors have treated upon the influence which food exercises upon both the mental and physical qualities of man. Thomas Tryon, in his "Book of Aphorisms," published at London, in the year 1696, recommends his readers to select for food those things that are most simple and innocent, because, as he says, the essences of things very often incorporate themselves with man's nature. Meat he considered to be a "fierce" food. This author, it would appear, anticipated the parody on a well-known saying—"Tell me what you eat and I will tell you who you are." Dr. Lambe, 50 years ago, argued that the disposition of men, as well as of the inferior animals, is greatly influenced by the nature of their food, and warmly advocated the exclusive use of vegetable food by man, as the best material means of making him not only more mild and humane, but even more intellectual. Many other writers have followed in Dr. Lambe's wake, but this physiologist's views relative to vegetable food have not met with general acceptance. Many distinguished writers on animal physiology have asserted that man is naturally an omnivorous animal; and Dr. Carpenter, to whose opinion the greatest respect is due, states that the greatest *intellectual* vigor is to be found amongst those who use a partly animal, partly vegetable, diet. The maxims that nations are composed of the same stuff as that which forms their food, and that refined manners are generally the concomitant of refined eating, are by no means confined to the circle of scientific men; indeed, the subject of the influence of food on the intellect is to be met with in the works of the traveller, of the poet, and even of the novelist. I shall give an extract from a work* by a writer of fiction, in which this subject is humorously treated:—

"If I understand you right," said the disputatious gentleman, in

* *Visiting my Relations and its Results.* London, 1852.

answer to a very startling affirmation on the part of Mr. Grey, "you enunciate this proposition:—That all sorts of food have their simile or duplicate in the nature of man: he just becomes that kind of being which the nature of his diet is fitted to make him—that is to say, bread and vegetables being of a mild, simple kind, by living on them, he also becomes mild and simple?"

"Unquestionably," said Mr. Grey, "just as by eating flesh he becomes of the nature of the animal he devours."

"Sheepish for mutton, calfish for veal, and so on."

"You have yourself been probably dining off veal to-day, sir," said Mr. Grey. A witticism which elicited a general laugh, in which the individual at whom it was levelled joined as heartily as the rest.

In the excellent work of Professor Moleschott, of Zurich, *Lehre der Nahrungs mittel, fur das Volk*, the influence of diet on the intellect is dwelt upon at great length. This philosopher points out the fact that the cat, originally a ferocious and carnivorous animal, has been changed by the influence of food into a domestic animal, the fireside companion of children. By gradually accustoming it to vegetable food, the structure of its digestive canal has been greatly altered, and aliments which the wild cat could not live upon nourish the body of the domesticated variety. Need we wonder, says Moleschott, that food which has made gentle an animal naturally the most perfidious, has an effect upon men's nature, rendering them ardent or phlegmatic, strong or feeble, brave or cowardly, intellectual or unintelligent, according to the nature of the aliments they use! He believes that well baked bread, lean meat, young vegetables, and roots of ready digestibility constitute the appropriate food for the artist, the poet, the literary man, and, in a word, the brain-workers. Rich gravy, greasy meat, heavy bread create gloomy forebodings, and render men irritable and morose, and disposed to look upon the dark side of life's pictures.

To the Rev. Professor Haughton, of Trinity College, Dublin—a worker in almost every department of science—we are indebted for an admirable physiological investigation, the results of which would appear to establish

the curious fact that the *greatest*, or, perhaps, we should say, the *hardest*, *thinker is the greatest eater*. The Professor asserts that a man who labors neither bodily nor mentally, but who merely *lives*, excretes, for every pound of his weight, two grains of urea per diem. Thus, a man weighing 150 lbs., and engaged in no physical or mental employment, excretes daily 300 grains of urea. Urea being one of the products of the decomposition of the nitrogenous animal tissue, it is necessary that a man should consume a quantity of food capable of yielding an amount of nitrogen equivalent to that contained in 300 grains of urea. This quantity of food suffices, according to the Professor, *to keep alive* 150 lbs. *weight of man*, and the work done by the food is termed, *Opus vitale* (vital work). In the case of a working man of standard (150 lbs.) weight, the amount of motive power developed by or in him is indicated by the quantity of urea eliminated from his body, which, in the case of a hard working laborer, is about 100 grains. We find, then, that a man employed in manual labor of an unintellectual character must consume a quantity of food sufficient, by its decomposition, to yield 400 grains of urea; and of this quantity of aliment three-fourths are expended in keeping the body alive, and the remaining fourth in mechanical work—*Opus mechanicum*. A man engaged in mental labor eliminates a quantity of urea varying, according to Professor Haughton's experiments, from 486 grains to 510 grains, from which it is to be inferred that mental work (*Opus mentale*) causes a greater waste of tissue than manual labor. Men employed in mere manual routine labor require only a vegetable diet; whilst those who are engaged in pursuits requiring the constant exercise of the intellectual faculties must be supplied with food of a better kind—that is, with mixed animal and vegetable aliments.

These interesting experiments of Professor Haughton and those of other enquirers in physiological science

open up a wide field of curious and interesting inquiry. Is vital activity a mere modification of chemical force, and is the explanation of all the phenomena of living beings to be found in the domains of chemistry and the various physical sciences? No doubt, many of the changes which take place during the different stages of the life of an animal can be clearly traced to the unmodified action of the various physical agencies, but there are others which are not so easily explained, and which some physiologists refer to the operations of a force which they regard as distinct from all others, namely, the *Vital*. It should, however, be remembered that this force, as it is called, never evidences its independent nature by any *unaided* manifestations of a material character. It has never been proved that any portion of matter, however small, has been caused to change its position in space by the sole agency of the vital power.

Although the physical sciences are so intimately related that there is not one that is not connected with others by many points of contact and resemblance, yet every one of the forces of which these sciences treat exercises upon matter an unmistakeable mechanical action, the character of which is peculiar to the particular force, and by means of which, indeed, we are alone enabled to recognise the nature of the force itself. Now, if vitality be an actual power, it ought, like the other active agencies of nature, to be recognizable by its independent action upon matter; but the most ultra-vitalists have not succeeded in adducing proofs of its power in this respect. What, then, it may be asked, is the vital force? Liebig regards it not as a force *per se*, such as we understand by the term electricity, heat, or magnetism, but rather as a collective term, including all those causes on which the vital properties depend. In this sense he says it may be used with as much propriety as the name of the "force of affinity" or "chemical force," which denotes the causes

of chemical phenomena, of which so little is known. Matteucci, who, in his admirable work on the "Physical Phenomena of Living Beings," has thrown so much light on many previously obscure parts of the domain of physiology, regards vital activity, so far as animals are concerned, as the result of chemical changes in the food which take place in the animal mechanism.

There is the clearest evidence of the absolute dependence of vital action of every kind on purely physical conditions. Every movement which takes place in any portion of the animal structure is certain to be preceded by a change in the chemical nature either of the structure itself or of some other organised body with which it is, if we may be permitted to use the term, *organically* connected. Muscular exercise is invariably succeeded by a loss of power; and the expenditure of animal motive power can only be sustained by the constant decomposition of part of the animal mechanism, and of the food supplied to it.

How does the food, in the process of its decomposition, develop motive power? We know that the grouping of atoms of matter into organized bodies, such as starch, sugar, and albumin, is effected by plants, under the influence of sunlight. Such substances, there is reason to believe, should not be regarded merely as "consolidated masses of the atmosphere and water," but also as accumulations of *force*. When these substances are disorganised in the mechanisms of animals, the force which was previously pent up in them is set free; part of it takes the form of heat, a portion of it occasionally (perhaps always) is resolved into electricity, and part is converted into muscular, or animal motive power. The heat set free by the disorganisation of food in the animal economy differs in no respect from that developed by the combustion of fuel in our furnaces; and by means of the electricity procurable from the torpedo every phenomenon peculiar to that variety

of force can be exhibited. It is only by carefully studying the nature of every kind of force manifested through the agency of animal life that we can determine whether vital action is the result of the conjoint influence of the ordinary physical agencies—modified by the peculiar state of aggregation of the atoms of matter on which they act—or that, in addition to the physical forces set free by the destruction of the animal mechanism and by the decomposition of the food, there is developed a peculiar force correlated to the physical forces, but differing in its manifestations from each of them in the same way that electricity differs from magnetism, or light from heat.

In Professor Haughton's experiments it is shown that a man of 150 pounds weight could not exist without being supplied with a quantity of food containing nitrogen equivalent to 300 grains of urea. The whole of the motive power developed during the decomposition of this amount of food, or of the tissues into which it is transformed, is employed in carrying on such operations as the circulation of the blood, the working of the heart and lungs, and other vital processes. In this case we can fully account for the motive power developed during the decomposition of the food—it is converted into *heat* and *motion*: the force set free by the decomposition of the food, or of its equivalent in tissues, which carries on the *Opus mechanicum*, is also fully accounted for; but what becomes of the force liberated during the decomposition of that portion of the food of the *thinking* man which is employed in the *Opus mentale?* Surely, the heat, and the light, and the other forces expended in grouping together the elementary constituents of the food are not destroyed within the animal mechanism! If mechanical philosophy teach truly, it is as impossible to annihilate force as it is to annihilate matter; but there certainly does appear an annihilation of force in the case of the food con-

sumed by the brain-working man—unless, indeed, we suppose that the force which, in the case of the laboring man, merges into motion is, in the thinking man, converted into *ideas!* This hypothesis is, after all, not much more startling than Dr. Elliotson's notion—that *the brain thinks in the same way that the liver secretes bile.*

According to Liebig, Ranke, Lyon Playfair, and some other physiologists, mechanical energy is derived from the oxidation of the nitrogenous, or muscular tissue of the body; but Mayer, and, very recently, Voit and Frankland, maintain that the muscle is merely a mechanism by means of which the force derived directly from the oxidation of the blood is applied. This question, though of physiological interest, is not of much practical importance, because the force set free in the body depends upon the quantity of food consumed within it, in the form of unaltered food, or of blood, or of flesh. The amount of work performed by a man is estimated by the weight which he is capable of raising to a certain height. The hardest day's work of a strong man is only sufficient to raise 400 tons 1 foot high, or 1 ton 400 feet high. The combustion of 2 ounces of albumin generates heat sufficient to raise 346 tons 1 foot high. As the amount of albuminates necessary to keep a man alive is known, it is not difficult to calculate the quantity which, if supplied to him in excess of that amount, would enable him to perform a certain amount of work. Frankland has determined by combustion the amount of different kinds of food which evolve by combustion an amount of force equivalent to that daily required to sustain the life of a man. The diagram shows the weight in ounces:—

Cabbage ...	... 31.8	Lean ham ...	... 7.9
Carrots ...	... 25.6	Lump sugar	... 3.9
Milk ...	... 21.2	Flour ...	... 3.5
Potatoes ...	... 13.4	Pea meal ...	... 3.5
Lean veal ...	... 11.4	Oatmeal ...	... 3.4
Lean beef ...	... 9.3	Butter ...	... 1.8

These figures show the relative heat or force producing power of these aliments when consumed *outside* the body, but they will not possess quite the same relative values, when consumed within the animal mechanism—their relative digestibility interfering with this point. However, such results as those of Frankland's are very valuable, and tables constructed upon them will, no doubt, yet prove most useful in arranging dietaries. All the force pent up in food is not evolved from it within the body; for some of the waste matters thrown off from the system admit of being burned, and develop a considerable amount of heat.

The preservation of food is a process which has been conducted from a very remote period of the world's history. It is accomplished by mixing the food with some antiseptic substance—such as, for example, salt or sugar—by drying it, or by excluding it from the action of the atmosphere. Succulent vegetables, fruits, and the flesh of animals are the food substances which are most difficult to preserve. Ordinary salted meat keeps in an eatable condition for a year or so, but after that time its nutritious qualities and its flavor rapidly deteriorate. Salted meat is not nearly so nutritious as the fresh article, because it is deprived of a large proportion of its saline constituents, and its fibres rendered hard and less digestible. Professor Morgan, of Dublin, preserves the flesh of animals by injecting the whole carcass with a brine composed of saltpetre, sugar, spices, and a little phosphoric acid. This process is a most expeditious one, and appears to answer the inventor's expectations; its sole disadvantage—though not, as it appears to me, a serious one—is that it removes all the nutritive matters from the vessels of the carcass. I believe Dr. Morgan's plan is now extensively adopted in South America.

Various purely chemical processes for preserving meat have been patented within the last fifty years. The meat is placed in vessels, and the air removed from it,

and replaced by various gases, such as sulphurous acid, carbonic acid, and nitrogen. The vessels and their contents are then heated to from 240 to 280 deg., and hermetically sealed. Foods are also preserved by coating or varnishing their surface with plaster of Paris, gelatin, or various other substances which do not permit the passage of air. Messrs. Medlock and Bailey, of Wolverhampton, have patented a method of preserving all kinds of animal food, an interesting description of which was given by Mr. Wentworth Scott in a paper on the "Supply of Animal Food," read before the Society of Arts in February last. They use a solution of bisulphite of lime—a salt possessed of such remarkable antiseptic properties that no animal substance can decay so long as it is in contact with it. The great advantage of Medlock and Bailey's solution is that it requires no machinery to apply it, and can, therefore, be used in the houses of the very humblest classes. If we wish to preserve a joint of meat untainted in very warm weather—under ordinary circumstances no easy task—we have only to give it a dip twice a day in a mixture of solution of bisulphite of lime and water. It is stated that to merely rub a joint with a cloth moistened with this solution is sufficient to preserve it sweet, even when the thermometer stands at 90° in the shade. Bisulphite of lime, though in small quantities perfectly innocuous to the higher animals, is fatal to the low forms of animal life. I believe, therefore, that this salt would be found an invaluable addition to the pickle used in curing pork and beef, as it would certainly destroy any *trichinæ* or *cysticerci cellulosæ* that might happen to be present. Medlock and Bailey's solution is now very generally employed to preserve for short and prolonged periods of time, meat, game, poultry, eggs, and fish; and it is found to exercise a powerful antiseptic action, without injuriously affecting the quality or nutritive power of the food. During the intensely warm weather which has prevailed for some

time past large numbers of game, moistened, so to speak, with this preparation, have been conveyed to London from distant parts of the country. I have just seen a letter from Sir James Mathewson, M.P., in which he states that he was enabled, by the use of the bisulphite of lime solution, to convey a deer from Stornoway to London. At the end of the journey, which lasted for four days, the carcass was found to be perfectly sound, and remained so for twelve days afterwards—when, I suppose, it was cooked and eaten. Mr. F. Hutchinson, the British consul at Rosario, River Plate, states that he tasted a specimen of beef cured by the bisulphite solution, which had been imported from England. He describes it as the first juicy piece of meat which he had tasted for seven years. Messrs. Medlock and Bailey's preservative solution is recommended in most favorable terms by many scientific men, medical officers of health, physicians, butchers, fishmongers, and meat-curers. In Ireland, where bacon-curing is so important an industry, I have no doubt this solution will be largely employed.

LECTURE VII.—ON FOOD ADULTERATION AND DISEASED MEAT.

There are many classes of articles which are constantly adulterated—that is, mixed with inferior or worthless stuffs, which simulate the appearances, but do not possess the properties, of the genuine commodities. When this kind of fraud—for it deserves no milder appellation—is practised upon food, not only are we robbed of our money, but even our health is often jeopardised; for several of the substances used in food sophistication are far from being harmless in their effects. In several Continental States severe laws have been enacted for the purpose of preventing the adulteration of food; and persons convicted for offences against those laws are not only fined, but are frequently imprisoned, and their names and misdemeanors advertised at the delinquents' expense in the newspapers. Several centuries ago food adulterators were severely punished in England. In the "Memorials of London" it is stated that in the year 1316 a man and a woman were sentenced to expiate on the pillory the offence of selling bread made of bad materials. Four years later, one William Spelying, detected in the act of selling putrid meat, was punished by having the unwholesome article burned under his nose—a species of chastisement which had a spice of humor in it; as was also the case when, in 1364, a vendor of bad wine was compelled to drink a large quantity of it. In 1419 Henry V. issued a proclamation threatening with the penalty of exposure on the pillory all who sold fraudulently compounded wine.

In modern times very little was done to check the practice of food adulteration until 1862, in which year

an Act was passed enabling municipal and other local authorities to appoint public analysts to examine food suspected to be adulterated. Anyone desirous to have a specimen of bread, milk, or any similar article analysed need only pay for that operation a fee, the maximum of which is 10s. and the minimum 2s. 6d. When purchasing the food, the buyer must state that it is to be submitted to the public analyst, in order that the seller may, if he wish, have the opportunity of accompanying the purchaser, so as to prevent the specimen from being tampered with. Very few public analysts have as yet been appointed in the United Kingdom. In 1862 I was elected to that office by the Corporation of Dublin, and, as I receive a salary, the fee for each analysis made for the public is limited to 2s. 6d.—a purely nominal charge, and merely intended to render the transaction *bona fide*. If the public analyst certify that the food is adulterated, the vendor is liable to a fine; and on a repetition of the offence the magistrates are empowered to publish the circumstances of the case, at the expense of the convicted vendor, in the newspapers.

Wheaten bread is liable to be adulterated with rice flour—which is cheaper, and absorbs more water—and with potatoes, which are also cheaper, and are useful in hastening the process of panification. Alum and lime-water have often been detected in bread; they are supposed to improve its color. Magnesia, sulphate of lime, and pipe-clay are stated to be employed to whiten bread, and to increase its weight. The only foreign matters which I have detected in bread are potatoes, rice, and alum; and of these alum, being a powerful astringent, is the only ingredient injurious to health.

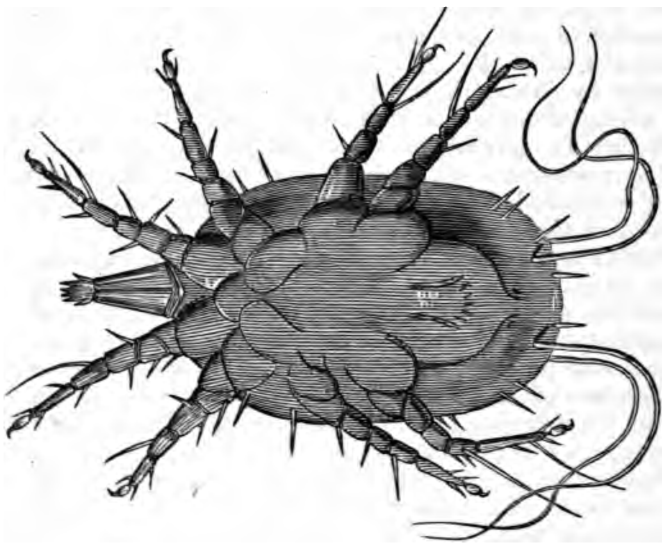
Wheat flour is often adulterated with rice flour, and rice flour with terra alba—a kind of white earth. Quite recently I found from 20 to 30 per cent. of terra alba in samples of rice flour sold in Dublin. Some of the starches are better flavored food than are others.

Bermuda arrow-root is, perhaps, the most valuable of the starches for dietetic purposes; but it is seldom obtained pure, being mixed with various inferior starches.

Good butter should not contain more than one or two per cent. of saline matter, if fresh, or, at the most, 7 per cent., if salted; but in one instance, during the present year, I found 33 per cent. of salt in a sample of butter. I am happy to say that the vendor was fined by the Lord Mayor. By ingenious manipulation, water is often added in large quantities, even to the extent of 35 per cent., to butter; and in very cold weather the interior of a roll of butter has often been found to consist of a snowball. A spurious kind of fresh butter is made by dissolving the salt out of cured butter, and washing the product with sweet milk. This stuff is produced in large quantities in London, and also, but on a very limited scale, in Dublin. Butter should never be purchased from hawkers, because they invariably vend an adulterated stuff.

Milk is rarely obtained in a state of absolute purity in towns. In London, it is stated that starch, gum, dextrin, carbonate of soda, chalk, sheep's brains, and various other objectionable matters are added to milk; and some go so far as to assert that fluids are sold under the name of milk which do not contain a drop of the genuine article. I believe these statements to be gross exaggerations; and I can say of the milk supplied to Dublin that it never contains any more serious adulterant than water. I have examined several hundred specimens of Dublin milk, and find that the water added to it varies from 10 to 60 per cent., the average being about 35 per cent. For some time past the Lord Mayor directs samples to be purchased by his officers, and to be analysed: if they are found to be adulterated, the vendors of them are summoned before him, and fined. Nearly fifty dairymen have been fined since this system was commenced, and the effect is now seen in the improved quality of the

article. In 1864, several samples of milk having been submitted to me for analysis by the Poor Law Guardians of the Mountmellick Union, I found one of them to contain 67 per cent. of added water. The specimen consisted, in fact, of two parts of water and one of milk. I have never met with another case quite so bad. Cheese sometimes, but rarely, contains starch: traces of copper and arsenic have been met with; and persons have more than once been poisoned by eating cheese containing these dangerous metals.



SUGAR MITE, MAGNIFIED ABOUT TWO HUNDRED TIMES LINEAR.

Sugar is almost invariably met with in a genuine state. Lump sugar is almost absolutely free from natural impurities; but raw brown sugar generally contains the spores of plants, and vast numbers of a minute insect, resembling those, which, by burrowing in the

skin, produce *scabies*, or itch. The diagram shows the appearance presented by this sugar insect, or *Acarus sacchari*. Somewhat similar insects occur in mouldy cheese and flour. Brown filtered sugar does not contain these ugly, little creatures. But one sample of adulterated sugar has come into my hands, and that contained a large proportion of flour. The sand and clay which are occasionally found in raw sugar are accidental impurities.

Tea is said to be adulterated with sloe, oak, willow, beech, elm, poplar, and hawthorn leaves. Tea leaves which have already been deprived of their soluble matters are dried, and mixed with the fresh leaves: this is, I believe, one of the commonest forms of adulteration. These exhausted tea leaves are sometimes steeped in solutions of gum, and mixed with catechu and dextrin, or British gum. The fine flavor of tea is a sure test of its purity; for no compound of exhausted tea leaves and catechu can simulate the properties of this fragrant herb. The color of green tea is generally due to a covering or "glaze" of Prussian blue and turmeric, or of a salt of copper. Coffee is more frequently adulterated than tea is. Wheat, beans, potatoes, starch, sugar, and chicory are the usual adulterants. In one instance, packets of a brown powder, covered with tin foil, and labelled pure "coffee," were submitted to me for analysis. I found them to consist of cocoa nut dust, roasted wheat, and no less than 6½ per cent. of sand, evidently derived from millstones. The vendor was fined by the Lord Mayor. Chicory is an astringent substance, and I cannot regard it as a harmless adulterant. Chicory itself is liable to be adulterated with roasted cereal grains, leguminous seeds, acorns, mangel wurzel and other roots, and even the baked liver of the horse! Chocolate and cocoa are often adulterated with flour, starch, and sugar; and, according to Hassall and Normandy, they have been found to contain Venetian red, raddle, brick dust, and rust of iron.

Sugar confectionary is rendered pleasing to the eye by imparting to it the most brilliant shades of red, green, and yellow. Formerly a compound of copper and arsenic (Scheele's green) was employed to color articles of confectionary a bright green; and a fine yellow hue was produced by the application of a salt of lead, called chrome yellow. So many fatal accidents having occurred from eating confectionary colored with these poisonous pigments, and the practice of using such dangerous coloring matters having been loudly denounced by chemists and physicians, confectioners have now, with few exceptions, ceased to employ these objectionable ingredients. They, however, still use, though not to any great extent, plaster of Paris as a substitute for the more costly sugar.

Pickles prepared in copper vessels are liable to contain that metal. Two or three years ago I examined a large number of samples of what are termed "mixed pickles," and I found that all possessed of a bright green hue contained copper. English pickles are not so highly colored as the French; they are, therefore, not so likely to contain copper.

Condiments are very liable to be adulterated. The Excise authorities permit—not wisely, I believe—the addition of 0.1 per cent. of sulphuric acid to vinegar; but the manufacturer often exceeds this quantity fourfold, so as to make a weak article appear stronger. Muriatic acid is rarely added to vinegar: Cayenne pepper is a rather frequent adulteration; and common salt and burnt sugar have been detected. Lead and copper are occasionally present; but they may be regarded as accidental impurities. Mustard, according to some authorities, is never to be met with in commerce in a pure state; but this statement is not correct, for I have repeatedly analysed Colman's mustard, and invariably found it to be perfectly genuine. I must, however, admit that few articles are so liable to adul-

teration; some specimens containing from 20 to 80 per cent. of foreign matters. Turmeric, flour, Cayenne pepper, plaster of Paris, and clay are the usual adulterants employed. Pepper is adulterated with mustard husks, flour of wheat and rice, and linseed.

Wine is adulterated with almost every kind of spirit, such as brandy and whiskey. The coloring matters—such as logwood and Brazil wood—added to it have been enumerated by the score. Chalk and lead are added to correct ascescency; and alum and tannin are used to increase the astringency of poor wines. Inferior wines are sold under the title of a better article. A large—perhaps the largest—portion of the wine sold as Port is made up of small portions of that wine, mixed with Marsala, Cape, and Bordeaux red wines. High priced wines are often very much adulterated; on the other hand, low priced wines—even the "Chancellor's claret" at 12s. per dozen—are often perfectly pure. I believe that, with the exception of adding brandy to still wines, and syrup to sparkling ones, very little adulteration is practised. Throughout the wine growing countries there are enormous quantities of inferior and very bad wines prepared: these are often confounded with adulterated wines. French brandy of the best quality is easily obtained in these countries, if a good price be offered; but a large proportion of so-called Cognac brandy is a compound of common corn spirit with various flavoring matters. Whiskey is always adulterated with water by the retailers; and it is sometimes "flavored" by the addition of prunes, tea, and other substances. It is sometimes sold when fresh, and is then popularly supposed to contain oil of vitriol, bluestone, or copperas. Such substances may be added to whiskey, but I have never met with them in that fluid. Across the Channel it is stated that gin is sophisticated with capsicums, oil of bitter almonds, and sulphuric acid. Beer and ale I have generally found to

be pure, but occasionally they are adulterated with water, sulphuric acid, lime, soda, salt, alum, burnt sugar, capsicums, pepper, grains of paradise, gentian, quassia, chicory, and cocculus indicus. There is reason to doubt the truth of the allegation, made some years ago, that strychnine was used to impart a bitter flavor to ale.

The amount of alcohol in spirituous beverages varies very much; on the average it is in rum from 60 to 75 per cent., in whiskey 50 to 60, in brandy 50 to 60, in gin, 48 to 58, port and sherry wine 14 to 27, claret 9 to 14, Burgundy 8 to 14, Moselle 8 to 13, Chablis and Sauterne 8 to 12, Champagne 8 to 12, Hungarian wines 9 to 14, Rhine wines 7 to 12, beer 2 to 3, ale 6 to 9, and in porter 5 to 7 per cent.

I am glad in being able to state that the practice of food adulteration is not prevalent in Dublin, the only article systematically sophisticated being milk.

There are few subjects relating to hygiene of more importance than that which I now propose to bring under your notice, namely, the diseases of animals used as human food. The Jews, since the times of Moses, have carefully abstained from the use of the flesh of animals that were in the slightest degree tainted with disease; and amongst this remarkable people there has always existed an officer, styled a bodek, whose function it is to examine the carcasses of the slaughtered animals, in order to ascertain their freedom from disease. In imperial Rome there were market inspectors, whose duty it was to examine the condition of the meat offered for sale, and butchers who evaded the inspection were heavily fined. In the middle ages, the London butchers were often severely punished for selling unsound meat. At the present time there exist in various Continental States the most stringent regulations for the suppression of the traffic in diseased flesh. In some countries it is not permitted to offer for sale the flesh of any animal killed whilst in a diseased condition. In the British

Islands the sale of unsound meat is almost openly conducted, except in a few places where the local authorities interfere in the matter. In the "City" of London —which embraces only about one-tenth of the metropolis—this nefarious traffic has, within the last few years, received a decided check, chiefly through the exertions of Dr. Letheby, the medical and chemical officer of the Corporation. That distinguished chemist informs me that he condemns putrid meat, and the flesh of all animals killed whilst affected with parasitic, acute inflammatory, or chronic diseases, or in a parturient condition. He also condemns, as being unfit for food, the flesh of animals that have died from accident or disease. Last year the enormous quantity of 129 tons of unsound meat was confiscated in London. In Edinburgh Dr. Littlejohn, the officer of health, is also most active in preventing the sale of diseased meat. Until very recently the inspection of meat in Dublin was confined to occasional visits of the clerks of the markets to the butchers' stalls; but owing to my suggestion, the Commissioners of Police appointed, in 1866, two constables to aid the clerks of the markets in their inspection of slaughter houses. These officers, and a third very recently appointed, have been most successful in seizing the carcasses of diseased animals. Every seizure is reported to me, and I make an inspection of the animal; and if I find it tainted with any serious disease it is either buried or despatched to the Zoological Gardens, where the vultures and other carrion eaters soon dispose of it. Last year the clerks of the market and the police seized upon a very large amount of meat, of which no less than 20,000 lbs. weight was condemned as unsound. Were it not for the strict *surveillance* of the police, very little of this large quantity of meat would have been detected; and not only so, but, emboldened by security, the traffickers in unsound flesh would probably have introduced still larger amounts into the city.

Pleuro-pneumonia is the disease of oxen which is most prevalent and fatal in this country. It is a fever which expends its energy chiefly upon the lungs and their investing membrane—the pleura. It was introduced into this country from the Continent about 28 years ago, and being very contagious, it has been propagated from animal to animal ever since. In the first, or congestive stage of this malady the lungs are found in a highly inflamed condition, and beginning to adhere to the pleura; but when the disease is far advanced, the pulmonary organs are enormously enlarged, in great part solidified, and frequently largely infiltrated with purulent matter. At first the flesh does not present an abnormal appearance, but when the disease is of more than a week's duration the muscles acquire a very dark hue, and become soft and watery. Pleuro-pneumonia, or infectious lung distemper, is never absent from the stock of the Dublin dairymen, whose losses from this disease cannot be less than 6 or 8 per cent. a year.

Oxen suffer from an infectious disease termed by veterinarians *epizoötic aphtha*, or *eczema*. It affects with ulcers the mouth, feet—between the hoof and hair—and the udders. The milk furnished by cows affected with this horrible complaint has been proved to produce disease in men, in calves, and in pigs. Cases of "foot and mouth," as this disease is termed, are of rather frequent occurrence in Ireland; and the carcasses of animals affected with it are often seized by the police in Dublin. Sheep also suffer from epizoötic eczema.

Anthrax fever is a disease which occasionally is met with in the ox. It is a highly inflammatory affection, and speedily causes the red, healthy tint of the animal's flesh to become brown, and in some places almost black. "Quarter evil" or "black-leg" is a form of anthrax fever attended with erysipelatous swellings. I condemned last year, as unfit for food, several animals affected with black-leg, which the police detected *en*

route to the slaughter-houses. The "braxy" of sheep and the *carbuncular cypanche* of swine are varieties of anthrax fever.

Pigs suffer from a disease popularly termed the "soldier;" a highly inflammatory malady, somewhat resembling scarlatina in the human subject. It was epidemic in this country last year, and I fear the result was that the sausage makers got great bargains. A large pig that died or was killed while suffering from this disgusting malady was sold for a few shillings to a sausage maker; but, fortunately, the police caught the carcass before it was introduced into the chopping machine. The explanation which the seller and purchaser of this animal gave to the Lord Mayor was not considered satisfactory, and his lordship fined each of them the sum of £2. I regret that it was not in his power to send them to gaol, and to restrict their diet to sausages made from "soldier" pigs, which would probably have been done in the reign of Henry V.

Animals used as food are very liable to be preyed upon by minute creatures termed *entozoa*, or internal parasites. The disease called *measles* in the pig is produced by little worms (*Cysticerci cellulosæ*), which take up their abode in the flesh between the muscular fibres. They are found in all parts of the carcass, and often occur just beneath the skin, on which they raise small protuberances. They are placed in bags, and vary from $\frac{1}{8}$ to $\frac{1}{2}$ an inch in length. Measly pigs have little protuberances on the inner surface of their eyelids, and a yellow speck in the angles of their eyes. The measle mounds, if I may use the term, may be readily felt on the under surface of the tongue. The animal's neck is generally very much swollen, and

Measle worm, partially protruded from its bladder.

its loins become very narrow. Measles are far more common amongst Irish pigs than those of England and Scotland. According to Professor Gamgee, more than 2 per cent. of our pigs are affected with this loathsome disease. The pork measle is an immature tape-worm (*Tænia solium*); and when it passes into the body of man, it becomes developed into that parasitic worm. It is not pleasant when we are eating a slice of measly ham—by no means an unfrequent occurrence—to think that we are possibly laying the foundation of a tape-worm ten yards long! The pork measle is destroyed by *perfect* cooking; and it is probable that if bacon be cured thoroughly, this little worm does not survive the salting and drying processes. At the same time, there is very clear evidence that badly cooked measly pork is extremely dangerous food. Another form of tape-worm (*Tænia mediocanellata*) occasionally found in man is believed to be derived from beef. Those who prefer their meat well cooked are not so liable to suffer from eating flesh containing parasites.

The "rot" in sheep and oxen is produced by the ravages of very large entozoa, popularly termed "flukes" (*Distomæ hepaticæ*), which take up their abode in the animal's liver. Flukes have been found in the liver of men, but very rarely. Whether the distomæ directly pass from sheep and oxen into the bodies of men is uncertain. It is evident that an animal very much affected with these parasites could hardly furnish wholesome meat. The "sturdy" in sheep is caused by a bladder worm (*Cœnuris cerebralis*), which lives in the substance of the brain. This parasite is not dangerous to man, but its presence in the sheep is likely to deteriorate the quality of the animal's flesh.

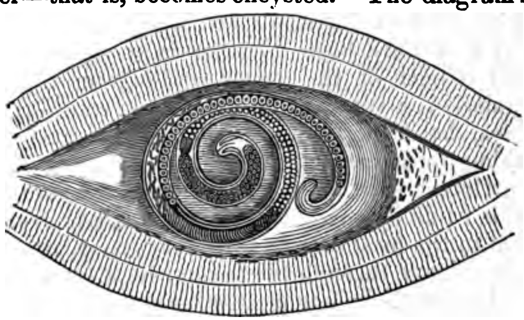
In 1835 Professor Owen described the structure of a human entozoön which had been discovered two years previously by a Mr. Hilton, demonstrator of anatomy in one of the London medical schools. From its hair-like

form he termed it *trichina*, and as it was found coiled up he added the adjective *spiralis* to its name. The *trichinæ spiralis* have since been discovered in the bodies of a great number of persons, and the disease induced by their presence has been termed *trichiniasis*. Since the discovery of the trichina in man several hundred cases have been detected; but it is probable that many persons die of *trichiniasis* whose decease is attributed to other causes, for the diagnosis of this malady during life is sometimes difficult. In Germany this disease has appeared more frequently than in other countries; and several times during the last few years it has assumed the proportions of an epidemic. In one small town, Hettstädt, in Saxony, four outbreaks occurred between September, 1861, and March, 1864. 192 persons were known to be affected, of whom 28 died. In July, 1864, 70 cases occurred at Stassfurt, in Prussia, of which several proved fatal. Trichiniasis has been observed not only in the British Islands and in many parts of the Continent, but also in America. In 1836 the late Dr. Harrison stated at a meeting of the British Association that he had detected six cases of trichina in the human subject. Since that time the anatomists of this city have occasionally encountered this worm. A few months ago I found thousands of them in the body of a man who died at Steeven's Hospital; and still more recently they have been detected in a subject in the Medical School of the Royal College of Surgeons. Trichiniasis is a very painful disease, producing fever, diarrhœa, headache, and excruciating muscular pains, resembling those occasioned by acute rheumatism.

The trichinæ exist in the pig, and when the flesh of this animal is eaten by man, the worms migrate from the stomach to the most remote parts of his body, producing by their passage through the tissues the most agonizing pain. Prolonged boiling or thorough roasting destroys the vitality of these worms. If, however, the cooking

be imperfectly accomplished, the trichinæ pass alive into the stomach. Neither smoking nor salting kills them, for Mosler found them alive in a ham kept for ten months. The greatest danger is to be apprehended from sausages, the central parts of which are often underdone, whilst the outer part is overdone. The cases of trichiniasis which have occurred in Dublin do not prove that the entozoa exist in Irish pigs; for they may have been derived from foreign bacon or ham consumed by the unfortunate patients. I have repeatedly carefully sought for trichinæ in the pork and bacon of home production, but never succeeded in discovering them. At the same time, I am far from believing that they do not occasionally occur in Irish pigs, though they have not yet been discovered in them.

Zoologically considered, the trichina is the juvenile condition of a very small nematode worm. From the eggs of this worm, which are deposited in the intestinal canal, the embryo issues, in the form of a minute thread, which immediately begins to bore its way through the abdominal wall into the muscular tissues. In about a fortnight the thread is developed into the well known form of the trichina, which, gradually coiling itself up, finally becomes invested with a coating of calcareous matter—that is, becomes encysted. The diagram shows



TRICHINA SPIRALIS.

the appearance presented by a trichina and its capsule. The trichina lives for a long time in his hermit-like cell, and in the encysted condition is harmless, or nearly so, to the human subject. When pork containing trichina is eaten, the juices of the stomach dissolve the calcareous cyst, and the liberated worm is then free to wander through the body and to multiply itself. The numbers of trichinæ which have been detected in morsels of flesh are very great. In a small piece—about ten grains weight—of the tongue of the subject to which I have already referred, I estimated the presence of at least 250 trichinæ. In some instances of trichiniasis in man, I have no doubt but that millions of these worms were present. The trichinæ have been found in rats, dogs, moles, hedgehogs, sheep, carnivorous birds, and even in frogs. By the aid of the microscope, the presence of trichinæ and other entozoa is readily detected.

There are not wanting physicians to assert that the flesh of animals killed whilst suffering from pleuro-pneumonia and many other serious diseases may be eaten with impunity. They say that chemical analysis fails to detect any poisonous matter in the muscles of animals affected with these diseases. This may be so; but it should not be forgotten that Lionel Beale, though employing microscopes of immense power, was unable to detect any difference between the cells, or elementary parts, of a malignant tumour and those of healthy flesh—between the cells of vaccine lymph and those of normal chyle. Organised structures may, indeed, resemble each other in their chemical and physical attributes, but their vital properties may be wholly dissimilar.

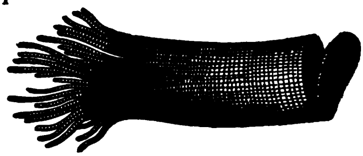
There are many cases on record which prove that serious maladies have often resulted from the use of diseased meat. Dr. Letheby states that in 1860 no fewer than 64 persons were affected with severe choleraic

symptoms after eating sausages made from the fore-quarter of a cow affected with pleuro-pneumonia. One of the cases having terminated fatally, the fact that death was produced by the diseased meat was established before a coroner's jury. Dr. Livingstone states that when the flesh of animals affected with lung distemper is eaten in Africa, it invariably produces carbuncle in both natives and Europeans. Since the introduction of this disease into the British Islands, it has been remarked that the deaths from carbuncle and phlegmons are annually on the increase. In the county of Kerry, a butcher died a few months ago in consequence of allowing the blood from an animal affected with carbuncular fever to come in contact with an abrasion of the skin of his arm. Two dogs and a pig, to which the offal of this animal was given, speedily died. Professor Ferguson sent the viscera of the animal to me, but I found no poison in them. At Newtownards, county of Down, two years ago, two persons died, and others suffered severely, after partaking of veal not obviously diseased, and in which analysis failed to detect any poisonous matter. Dr. Kesteven, in the *Medical Times* for March 5th, 1864, mentions a case where 12 persons suffered from choleraic symptoms after the use of pork, which was neither putrid nor poisoned. The disease called braxy, which affects sheep, is very common in Scotland. When the flesh of a braxy sheep is eaten fresh, it is certain to produce disease; but when corned it is generally consumed, though not always, with impunity.

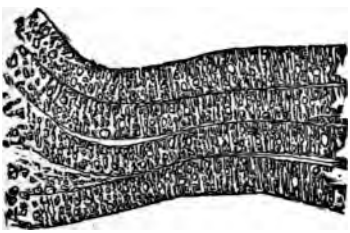
According to Dr. Leared, 20 per cent. of the deaths in Iceland are caused by parasites derived from the flesh of the sheep.

Diseased meat is usually dark, sometimes nearly black. Occasionally it has a bright pink hue, or, if not well bled, a purple color. It is generally very soft and flabby. I have often noticed a disagreeable odor,

which, on several occasions, was the result of medicine administered to the animal. The flesh of the healthy animal is very slightly acid, and changes the blue hue of litmus paper to a red tint; but occasionally the juices of the flesh of diseased animals possess an alkaline reaction, and restore the reddened litmus to its normal color. Diseased flesh being in general very moist, it loses a large proportion of its weight during the cooking process.



HEALTHY FIBRES OF FLESH.



FIBRES OF FLESH BROKEN UP BY FAT.

The flesh of over-fattened animals is said to be unwholesome, but there is no good evidence in support of that statement. At the same time, I am disposed to believe that the flesh of those bovine monsters that carry off prizes at our agricultural shows is deficient in nutritive power. The fibres of their muscles are either partially replaced by fat, or literally smothered in enormous quantities of that tissue. The diagrams show the structure of healthy muscular fibres and of fibres broken up by fat.

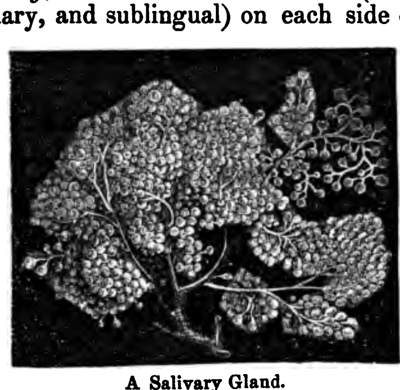
A very objectionable kind of animal food is that termed "slink veal." It possesses a loose texture, which allows a large quantity of air to be blown into it —usually from the *lungs* of the butcher or his assistant. It is very liable to cause diarrhœa, and its use should be prohibited when cholera is epidemic. It is not a nutritive food, the greater part of its solid constituents consisting of indigestible nitrogenous matters. I find in veal, one day old—

Water	72.25
Fat	6.17
Nitrogenous matters	18.46
Mineral matters	3.12
	100.00

Let us hope that all the private slaughter-houses in large towns may soon be abolished, and public *abattoirs* erected in their stead. Were this reformation effected, the systematic inspection of meat could be properly conducted, and very little, if any, diseased meat would then be surreptitiously introduced into the public market.

LECTURE VIII.—ON DIGESTION AND INDIGESTION.

Before food is converted into the tissues of the body it is subjected to various processes—mechanical, chemical, and vital. Digestion, in the most extended sense of that term, means the metamorphosis of food into blood. The operation of chewing, or masticating, reduces food into a pulp or into small fragments, so that it may be easily swallowed. During mastication a slightly alkaline fluid, termed *mucus*, is poured forth from minute follicular glands which stud the mucous membrane of the lips, gums, tongue, palate, and cheeks. Another liquid is secreted by much larger glands, termed *salivary*, of which there are three (the parotid, submaxillary, and sublingual) on each side of the mouth. The mucus and the fluid secreted by the salivary glands form *saliva*, the functions of which are of much greater importance than is generally supposed. It contains a peculiar principle termed *ptyalin*—a nitrogenous substance which very readily passes into a state of fermentation. The secretion of saliva is incessantly taking place, unless during certain diseases; and large quantities of it are abundantly swallowed voluntarily or involuntarily. An adult daily



A Salivary Gland.

secretes, on an average, about three pints of saliva. Its flow is much promoted by smoking tobacco (a practice which causes a great waste of this fluid); and during mastication the more savory the food is the more abundantly is the lubricating fluid produced.

Carnivorous animals secrete less saliva than the herbivoræ do, and for this reason—*ptyalin* converts starch into sugar, but produces no chemical action upon flesh. The fluid poured forth from the salivary glands of the flesh-eater is merely intended to aid the mechanical process of swallowing, or *deglutition;* but mastication in the herbivoræ is the first stage in the process of digestion. The hasty swallowing, or "bolting," of food is likely to produce dyspepsia. The more minutely food is comminuted, the more readily does it yield to the action of the gastric juices. Large pieces of meat remain undigested for a long time in the stomach, just in the same way that a large lump of sugar resists for a long time the solvent action of water, whilst powdered sugar almost instantly dissolves.

The great evil of imperfect mastication is, that the starch—which forms so large a portion of our nutriment—passes unchanged into the stomach, and imposes an undue amount of labor upon that organ. In the United States of America the various forms of dyspepsia prevail to an extent unparalleled in any other country, partly because in no other civilized country is food so expeditiously swallowed. Nature has ordained that the process of eating shall be productive of pleasure; why, therefore, should we deprive ourselves of the rational enjoyment derived from food, by devouring it with a rapidity that often only produces a sensation akin to that of choking? Rapid eating is a bad habit, which a little reflection as to its mischievous results would probably cure. It is often occasioned by permitting one's thoughts to wander from the subject of nutrition to other matters. At meal times our rules should be—to feel

grateful to a beneficent Providence for the good things set before us, to banish from our minds for the time all thoughts of the cares and responsibilities of our position, to eat slowly, to chew thoroughly, and to extract from our food all the enjoyment which it is capable of yielding. To strictly adhere to these rules does not imply that we are *gourmands ;* not to observe them will probably be the cause of some form of dyspepsia.

When the food reaches the stomach it is instantly subjected to the action of the gastric juice. This fluid is clear, limpid, and possesses a slightly sour taste. It is evolved from numerous little follicular glands situated on the mucous membrane of the stomach. It contains an active principle termed *pepsin,* which acts upon albuminous substances in the same way that ptyalin affects starch—that is, renders them soluble. Casein, albumin, and fibrin are very insoluble bodies, and clot, or coagulate at a rather low temperature; but when they are mixed with pepsin they dissolve in water, and no longer coagulate. The animal and vegetable foods that are rendered soluble by pepsin are termed *peptones.* According to Meissner, the action of the gastric juice resolves albuminous substances into two parts—peptones, which it dissolves, and para-peptones, which it does not affect, but which the pancreatic juice afterwards dissolves. The gastric juice produces little or no effect upon the starches, sugars, or fats; but the churning motions to which they are subjected by the muscles of the stomach reduces them to a very minute state of division. The quantity of gastric juice secreted is extremely large. Grünewaldt found that a woman affected with a gastric fistula secreted 31 pints in 24 hours. Of course, a large proportion of this quantity was reabsorbed by the mucous membrane of the stomach.

It is probable that a portion of the food digested in the stomach is absorbed by the surface of that viscus; but the great mass of it leaves the stomach, and enters

the short intestine—the first 12 inches of which constitute the *duodenum*. When the food leaves the stomach it is found a thin, pasty mass termed *chyme*. Three fluids are in the duodenum—a secretion of the intestine, bile, and pancreatic juice. The intestinal juice is a colorless or yellowish viscid fluid, and is slightly alkaline. It seems to unite in itself the properties of both saliva and gastric juice, as it converts starch into sugar, and dissolves albumin. The bile is secreted by the liver, and flows from that organ into the intestine. It is a mucilaginous alkaline liquid of a yellowish green color when concentrated, but of a bright yellow hue when diluted. Its composition is very complex. The pancreatic fluid is secreted by the pancreas—a gland situated behind the stomach, and termed the sweetbread in certain of the lower animals. This juice is colorless, rather viscid, and slightly alkaline. In its action upon food it resembles saliva, but it acts much more energetically than that secretion. Its active principle is *pancreatin*. It is supposed that an adult man secretes daily about 5 lbs. of bile, 10 lbs. of pancreatic juice, and 10 ounces of intestinal fluid.

The three fluids which I have described convert the chyme into a milk-like fluid, termed *chyle*. The surface of the duodenum, and, indeed, of the whole lower digestive canal, is studded with almost innumerable small points termed *villi;* they are little ducts through which the chyle is absorbed, and conveyed to minute tubes termed *lacteals*, which are situated in the walls of the intestine. The lacteals uniting form a net work of vessels within the fold of the mesentery, or membrane that connects the intestine with the abdominal wall. They next enter the mesenteric glands, on leaving which they unite, composing branches, which, gradually growing larger, at length form two or three trunks, which terminate in the thoracic duct (*Receptaculum chyli*), from which the chyle finally passes into the blood. The thoracic

duct, which is about a quarter of an inch in diameter, extends along the greater length of the vertebral column, and discharges its contents into a large vein—the subclavian—at a point where it joins the internal jugular vein. During its progress from the intestines to the veins, chyle gradually becomes more and more organized, until at length it forms an integral part of the blood—the fluid with which every part of the body is repaired. The large intestine absorbs chyle, but it does not possess digestive powers.

Dr. Beaumont performed a series of experiments with a Canadian, who, owing to an accident, had a fistulous opening leading direct to his stomach. By looking through this passage, the processes of digestion could be ocularly observed. The chymification of food may be performed outside the body by exposing it to the action of gastric juice obtained from the stomach. Dr. Beaumont made two series of experiments in order to determine the time occupied in digesting various kinds of food in the stomach of the Canadian, and in phials of artificial gastric juice heated to 100 degs. Some of his results are shown in the table:—

		Mean Time of Chymification. In Stomach.	
Foods.	*Preparation.*	*Hours.*	*Min.*
Rice	Boiled	1	
Eggs, whipped	Raw	1	30
Trout, salmon, fresh	Boiled	1	30
Venison steak	Broiled	1	35
Sago	Boiled	1	45
Barley	Boiled	2	
Milk	Boiled	2	
Eggs, fresh	Raw	2	
Milk	Raw	2	15
Turkey	Boiled	2	25
Gelatin	Boiled	2	30
Goose, wild	Roasted	2	30
Pig, sucking	Roasted	2	30
Lamb, fresh	Broiled	2	30
Beans, pod	Boiled	2	30
Potatoes, Irish	Roasted	2	30

Chicken	Fricasseed ...	2	45
Oysters, fresh	Raw	2	55
Eggs, fresh	Soft boiled ...	3	
Beef, lean, rare	Roasted	3	
Mutton, fresh	Boiled	3	
Pork steak	Broiled	3	15
Bread, corn	Baked	3	15
Butter	Melted	3	30
Cheese, old, strong	Raw	3	30
Potatoes, Irish	Boiled	3	30
Beef	Fried	4	
Veal, fresh	Broiled	4	
Fowls, domestic	Roasted	4	
Ducks, domestic	Roasted . ..	4	
Beef, old, salted	Boiled	4	15
Veal, fresh	Fried	4	30
Suet, mutton	Boiled	4	30
Pork, fat and lean	Roasted	5	15
Cabbage	Boiled	4	30

Beaumont's experiments have been repeated by other physiologists, and the general results of their enquiries appear to be that animal food is retained longer in the stomach, and is more perfectly digested, than vegetable food; that the digestion of vegetable food is very imperfectly performed in the stomach, the labor of the operation devolving chiefly on the intestines; that the denser the structure of the food, and the more nutritious it is, the longer does it resist the action of the gastric juice; that oily and fatty substances are the most difficult to be digested; and finally, that, as a general rule, roasted meat is more digestible than broiled and less so than boiled flesh.

The quantity of the gastric juice is proportionate to the wants of the system; therefore, if too much food be taken, the excess undergoes putrefaction in the stomach, and gives rise to acidity, fetid eructations of gas, windy distensions of the intestines, nausea, and even worse symptoms. On the other hand, insufficiency of nutriment weakens the digestive powers, by enfeebling the whole system. Over feeding is, however, a much more frequent cause of dyspepsia than deficient nutrition;

and it is probable that a very large proportion of the middle and upper classes impair their digestive organs by too freely indulging in the pleasures of the table. A bath—more especially if hot—impedes digestion if it be taken immediately after a full meal. Exercise produces a similar effect. Some people find that certain kinds of food, though pleasant to the palate, are obnoxious to the stomach. Many individuals, especially amongst children, dislike fats, whilst others are extremely fond of those substances. Even those who relish butter have often no desire for the other kinds of fat. Liquids which, like Bass's ale, have a bitter flavor are much enjoyed by, perhaps, the great majority of people; but there are many individuals who have an instinctive aversion to such beverages. Nature is in general a very safe guide in dietetics, and we should obey its promptings. No matter how nutritious a substance may be, according to chemical analysis, it should not be used by those with whom it habitually disagrees. I have often felt sorry for poor, little children who are forced to take food believed to be adapted to their wants, but which their instincts cause them to view with loathing, or, at least, with dislike.

Badly cooked and unsound food and impure water are common causes of dyspepsia. Meals should be taken with regularity, and with intervals between them which should be neither too long nor too short. Breakfast should be taken immediately after rising, and certainly before labor of any kind is commenced. It should be as substantial as possible. If an interval of more than six hours intervene between breakfast and dinner, some solid food is necessary between these meals—nearer, if possible, to the first than to the second repast. Late dinners, especially if abundance of food and alcohol be taken at them, are a common cause of indigestion: so also are heavy suppers; because, active digestion during the night disturbs the function of sleep,

and produces that unwelcome nocturnal visitant termed the "nightmare." The stomach requires rest; therefore, one meal should not be taken until the preceding one has been thoroughly digested. On the other hand, the long fasting stomach appears to secrete an abnormal amount of mucus, which interferes with digestion; whilst the system, becoming enfeebled for want of nourishment, the painful sensation of hunger is substituted for the pleasurable feeling of appetite. A full meal is not wholly removed from the stomach in less than from 4 to 5 hours. Children, however, require to be fed frequently. During infancy the development of the tissues takes place with great rapidity, and occasions an almost incessant desire for food. Prolonged fasting, irregularity in the periods of feeding, unsuitable food, and deficiency of nutriment are amongst the prime causes of the excessive mortality of children. After a long fast we should eat slowly. The feeling of hunger is not instantly removed by the introduction of food into the stomach. Voracious eating may, consequently, cause that organ to be overloaded.

There are cases where, owing to enormous amounts of gastric juice being secreted, the digestion of greater amounts of food than are necessary for the wants of the body is effected: under such circumstances, obesity is the evil which is substituted for dyspepsia.

As the quantity of food consumed bears a close relation to the amount of work performed, it is obvious that hard-working men require more nutriment than do those whose habits are sedentary. Many persons, when they substitute idleness for activity, continue to eat as heartily as before. Under such circumstances, enfeebled digestion, obesity, or both, are common results. An almost continuous stoop of the body and other constrained positions produce weak digestion. A large proportion of shoemakers and tailors are habitual dyspeptics. I am glad to learn that in some large establishments shoe-

makers now perform their work in a standing posture—more effectively, it is stated, that if they were seated.

There is considerable variation in the digestibility of foods; and at certain periods of life, and owing to idiosyncrasies, or peculiarities of constitution, many persons are unable to assimilate aliments that the great majority of people readily digest. Starch, the chief constituent of vegetable foods, is not easily digested by infants. Very young children do not secrete ptyalin, and as starch is not affected by the gastric juice, the digestion of this aliment takes place nearly altogether in the duodenum. I regard arrow-root, and all similar starchy foods, as very poor nutriment for infants. I have lately examined some specimens of "farinaceous food," prepared from rice by the Messrs. Colman, of Norwich; it contains, in addition to starch, about 6 per cent. of albuminous substances, a little sugar, and some saline matters. As it includes all the elements of nutrition, I consider it much better suited as food for children than arrow-root, which is incapable of forming bones, muscles, or nerves. Young people are instinctively fond of sugar, and as it is easily digestible, there is no good reason why it should not enter largely into the dietary of juveniles. Pure sugar exercises no injurious influence upon the teeth; but in some forms of dyspepsia, chiefly amongst adults, it produces lactic acid in the stomach, and it is possible that the sour eructations from that viscus may somewhat affect the teeth. The negroes in the West India islands, who consume enormous quantities of sugar, have usually very white and sound teeth; whilst people who subsist almost exclusively on animal food, and rarely or never touch sugar, suffer very much from diseased teeth.

Excessive quantities of fat impede digestion, most probably—as shown by Bidder and Schmidt—by preventing the secretion of bile. On the other hand, I have always regarded as very defective those diets which

are destitute of fats. In 1864 Dr. Edward Smith presented to the Government a report on the dietaries of the working classes, in which he stated that the average weekly cost of food per head was 3s. 5½d. in Wales, 3s. 3¾d. in Scotland, 2s. 11⅞d. in England, and 1s. 9¾d. in Ireland. He states that for this sum there was the *most* nutriment, the least variety of food, the greatest economy in food selection, the most breadstuffs and milk, and the least sugar, fats, meat, and cheese in Ireland, as compared with the other countries. Most people will learn with surprise that the lower classes in Ireland receive more actual nutriment than do the same sections of society in England and Scotland. Still, I believe that there is a serious defect in the diet of the Irish agricultural laborer and small farmer, which has not attracted notice, and that is its almost complete freedom from fats. The relative proportions of nitrogenous and non-nitrogenous matters in the potato are not very different from the relative amounts of those principles in the carcasses of fat oxen or pigs. The addition of animal food to a potato diet does not, therefore, alter the relative proportions of the fat-formers and flesh-formers; but the "ready formed" fat of the meat is more potential than the carbo-hydrates of the potato, which only undergo conversion into fat during the last stage of digestion. The poorer classes in towns who consume bread and butter usually prefer lean meat; but those who subsist nearly altogether upon the bulky and dry nutriment afforded by our so-called national esculent, the potato, instinctively long to combine it with the pure fat of bacon or beef. Fats and oils are the most powerful heat-producing foods, and are, therefore, highly prized in very cold countries. Within the Arctic Circle in winter, when the temperature of the air is often 150 degs. lower than that of the blood, a vegetable diet would not produce sufficient heat to preserve the body. Under those climatic conditions, nature implants in man a desire for fats and oils. The juice of

the melon and the bulky mess of boiled rice, which adequately serve to nourish the Hindu, would be rejected with disgust by the Esquimaux; whilst the train oil which the Laplander loves so well would speedily derange the digestive organs of the Indian ryot.

Beef and mutton head the list of meats. They are easily digested, very nutritious, and contain abundance of osmazome. Lamb is easily digestible, and is very tender; but it is not so rich in flavoring principles as the matured flesh of the sheep. Many persons eat mutton day after day for years, but very few like to dine constantly on lamb. Veal is very tender; in every other respect it is inferior to beef. Pork is usually a very fat meat, and requires a long time to be digested. It is not so generally relished as beef or mutton. The flesh of the goat is very strong flavored, and few stomachs tolerate it; but the meat of the kid is easily digested, and is moderately well flavored. The flesh of the deer is rich in osmazome, and yields very readily to the action of the gastric juice; but the way in which it is generally served—half raw, and in a state of semi-decomposition—renders it unbearable to some stomachs.

Fowl is an excellent food for the convalescent and the dyspeptic. It is tender and extremely nutritious, and though it remains for a long time in the stomach, it does not disturb that organ. The rich fat in the flesh of the goose renders it unsuitable to the sick and to persons of weak digestion. Duck occupies a middle place between fowl and goose.

Fish is poor in fibrin, but not in albumin. In nutritive power it is inferior to beef and fowl; and to most people it is an *unsatisfying* food, if it be the staple of the meal. Fishes rich in oil, such as the salmon, eel, and herring, are the least digestible.

Eggs are highly nutritious, and when fresh, and slightly boiled, they agree with most people; but when the secretion of bile is excessive, this kind of food is often found hurtful.

Gelatin forms the basis of most kinds of soups and jellies. There is a general belief that gelatin does not possess any alimental properties; but from the results of numerous experiments* which I have performed with it, I am quite satisfied that it is, when properly prepared, very nutritious. Animals cannot subsist exclusively on gelatin, neither can they on albumin, on fibrin, or on fat. It contains neither sulphur nor phosphorus; and this is the reason why it is incapable of forming muscles, even when it is combined with starch, sugar, or the ordinary fats. I find, however, that mice can live for an indefinite period on a diet composed of gelatin and the fats of the brain, in which there exist unoxidized sulphur and phosphorus. A mixture of gelatin and brain fat is, therefore, capable of forming lean flesh.

As we advance in years, appetite often fails, whilst the necessity for food is but little diminished. Condiments stimulate the appetite, promote the flow of saliva, and in many cases assist the assimilation of food. The desire for condiments, spices, and pickles is greatest in the meridian and decline of life. In warm climates the European often exhibits little inclination for food, unless his palate is stimulated by curries. In childhood salt is the only condiment required; for at that period of life the appetite rarely flags. Vinegar dissolves albuminous substances, with the exception of casein; it, therefore, promotes the digestion of those aliments. It also produces a solvent action upon several vegetable principles, and the popular practice of mixing it with salad is one to be commended on scientific grounds. If vinegar be largely used, it dissolves the muscular tissues of the body, and greatly impairs the digestive powers. There are ladies who employ this condiment, not for the purpose of imparting piquancy to their food, but

* See Macnamara and Neligan's *Materia Medica*, last edition, p. 831.

with the object of arresting their tendency to *en bon point;* this practice has often produced serious disease, and even death. Many persons are constitutionally disposed to obesity, and cannot avoid the dreaded accumulation of adipose tissue, except by bringing on themselves more serious evils. Persons short in stature, with stumpy hands and feet and fair complexion, exhibit a natural tendency to obesity; whilst tall individuals, with very prominent features, long and narrow hands and feet, and dark skin, in general remain thin, no matter how liberal and rich may be their diet. The cure for over-fatness must be found, not in Mr. Banting's remedies, but in out-door exercise, and in a light, moderate, and easily digestible, but not innutritious, diet.

Alcohol in some form is drank by man in all parts of the world, and in civilised countries enormous sums of money are yearly expended in purchasing it; yet it is a vexed question whether or not it possesses any nutritive value. That alcohol is incapable of forming any part of the body is admitted by all physiologists—it cannot be converted into brain, nerve, muscle, fat, or blood. Lallemand and some other experimenters maintain that every drop of alcohol taken into the system passes away from it unchanged; but the accuracy of this assertion has not been proved to demonstration. Alcohol has, no doubt, been detected in the matters thrown off from the body; but it has not been rigidly demonstrated that every ounce of this fluid introduced into the stomach may afterwards be found unaltered in the excretions. It is probable that traces of every kind of food consumed by man occur in the effete matters ejected from his body. I believe that Dr. Thudicum, of London, has lately found, from the results of numerous accurately conducted experiments, that alcohol is, if not wholly, at least largely, oxidized within the body. The results of recent physiological experiments seem to prove that the oxidation of blood is one of the sources

of animal motive power. There are many physiologists who believe that even food is burned in the animal economy; and if their views are correct, I see no reason why alcohol may not be regarded as a food, although it may be incapable of forming tissue. The functions of food are two-fold: it repairs the animal mechanism, and it evolves force. I am quite satisfied that one of these functions is performed by alcohol. Admitting that alcohol is oxidised in the body, we can easily understand the advantages of employing it in the treatment of certain diseases. During the progress of inflammatory and of some other maladies, there is great waste of tissue, and no appetite. Under such circumstances, there are cases when ordinary food will not be assimilated, because the digestive organs are enfeebled, and either partly or utterly refuse to act. In such cases the action of alcohol is beneficial, because it furnishes, by its oxidation, heat, and probably motive power, and thus economises the expenditure of living tissue.

Alcohol is a very costly food—a luxury, in fact—and the consumers of it contribute largely to the revenue of the state. The advocates for the prohibition of the sale of intoxicating beverages are, whether knowingly or not, acting a more than disinterested part; for, were the community to abandon the use of alcohol, the duty now levied upon that article would be imposed upon some others—probably upon tea, coffee, and sugar. At present the drunkards and those who smoke tobacco in excess are the most highly taxed members of the community. There is less drunkenness in countries where wine is the popular spirituous beverage than in those where distilled spirits are commonly drank by the people. I therefore regard as a favorable omen the growing partiality for wine, which is observable amongst the middle classes, and even in the upper section of the lower classes of society. In the middle ages wine was the alcoholic beverage of the common people; and Froude informs us that in the reign of Edward VI. a pint of

French light wine formed part of the daily rations of a soldier. Nor need we apprehend that cheap wines are necessarily adulterated; for it is easier to get a pure claret at 12s. per dozen than an unsophisticated port wine at four times that price.

On the enormous evils of intemperance I need not descant—they are, unfortunately, patent to the world; but were all who use alcohol in moderation to become teetotallers, I do not think that the number of drunkards would be sensibly diminished.

Tea and coffee have a physiological action in some respects resembling those of alcohol. They produce a feeling of exhilaration, and aid digestion. There is very little nutriment in them: they should not, therefore, be substituted for milk, unless a substantial addition be made to the solid items of the meal. According to Böcker and Lehmann, tea and coffee increase the action of the body, yet, at the same time, retard the decomposition of the tissues—statements which seem to involve a paradox. To me it appears that tea and coffee cause a more perfect assimilation of food, and thus apparently, though not really, retard the wasting of the body. Tea and coffee are best taken without milk, the albuminous principles of which they render less soluble. Their effects are most beneficial when taken an hour or so after dinner they stimulate the flagging energies of the digestive organs.

Tea contains an active principle termed theine, which is identical with caffeine, the chief nitrogenized ingredient of coffee. In cocoa there exists a substance termed theobromine, which, in many respects, resembles caffeine. Cocoa and chocolate therefore produce on man a stimulating influence, resembling, but not so energetic as, that exercised by tea. They are, moreover, nutritious substances, containing large proportions of albumin and fat. Tea and coffee are not necessary—perhaps not desirable—in childhood. In old age, especially amongst

females, they are indulged in to excess, and dyspepsia is the most frequent result of what may be termed the intemperance of the use of tea and coffee.

Smoking tobacco produces, in general, a soothing effect on those accustomed to its use; nevertheless, this practice is objectionable. It creates the inelegant habit of spitting, taints the breath, and when indulged in to excess, produces disease of the respiratory or digestive organs. It is a pernicious habit in boys; but there is no satisfactory evidence to prove that adults who smoke *very moderately* are more liable than others to contract disease.

Badly cooked food is a common cause of indigestion, and the unskilful cook wastes much valuable nutriment. The loss of weight meat sustains by boiling varies from 20 to 40 per cent. If we wish the loss to be as small as possible, we should put the meat into boiling water, and after a few minutes allow the temperature to fall from 212° to about 160°. By adopting these precautions a layer of coagulated albumin is formed on the surface of the joint, which prevents the valuable soluble juices of the meat from oozing out. If we wish to make soup, the temperature of the meat must not be raised to the boiling point. In roasting, the meat should be highly heated for a few minutes, and then cooked as slowly as possible. Baked meat is not so digestible as boiled or roasted. The action of heat on butter very often renders it indigestible, in the case of persons habitually troubled with acid dyspepsia. Pastry, some kinds of cakes, and mashed potatoes generally contain butter, which, owing to the action of heat, has been partly converted into butyric acid and other sour substances. These kinds of food should be avoided by persons who suffer from heartburn. In cooking vegetables, care should be taken to perform the operation thoroughly. Underdone and unripe vegetables are a most prolific cause of diseases of the digestive organs. Veal should be thoroughly cooked, in order to kill the dangerous parasites which it so often contains.

LECTURE IX.—ON ABLUTIONS, CLOTHING, AND EXERCISE.

The surface of the body is covered with a tegument, which is devoid of nerves and blood vessels, and is termed the scarf skin, cuticle, or epidermis. Beneath it lies another membrane, called the cutis, dermis, or true skin, which is sensitive. There are immense numbers of minute blood vessels in the cutis, a rush of blood into which causes blushing and its recession from which produces pallor. The microscopic appearance presented by these *capillary* vessels is shown in the diagram.

Blood vessels of the skin.

Between the two skins there is a layer of cells, in which is developed the pigment which produces the various shades of complexion that distinguish the races of man, and even the different individuals of each nation. The nerves of the cutis are very numerous; they project from the surface, and may be easily examined through the microscope. They abound at the finger ends. There are small glands which are connected on one side with the blood vessels, and on the other with convoluted tubes, which, passing from the cutis, pierce the scarf skin, and terminate in openings termed pores. According to Erasmus Wilson, there are on the average 2,800 of these pores on each square inch of the 25,000 on the surface of a man's body, the average length of each tube being about the tenth of an inch. Through these little openings a large proportion of the water introduced into the body, and produced by the oxidation of the hydrogen of the tissues, is exhaled. They constitute, in fact, a

system of human drainage, or sewerage pipes; and if they were placed one after the other, they would form a tube 28 miles in length.

There are, beside the perspiration glands, others, termed sebaceous follicles; they secrete a fatty matter, which serves to keep the skin moist, and prevents it from being too rapidly heated or cooled. These glands are very numerous on the face; and when their function is deranged, a pimple is generally the result: what is popularly termed a flesh worm is simply the discolored contents of one of these tubes. They, however, are occasionally the abode of a small creature, belonging to the family of *Acaridæ*, or mites. The diagram shows the appearance presented by a vertical section of human skin. The large tube rising above the surface of the cuticle is a hair, from the base of the sheath of which a minute muscle passes off obliquely. Two sebaceous glands open into the sheath of the hair, and in each gland there is contained a *Demodex folliculorum*, or flesh mite. The left part of the diagram exhibits the structure of the perspiriferous duct, or sweat tube; it is long, very slender, and spiral-shaped.

SECTION OF SKIN.

The functions of the skin are of the very greatest importance. It not only protects the body from mechanical injury, but it enables it to get rid of various effete matters and of its surplus heat. By the combustion of tissue or of food enormous quantities of

heat are developed within the body. When the temperature of the air is very low, it is desirable to economize this heat; but when the atmosphere is warmer than the blood, the heat of the body must be got rid of speedily, or else death would ensue. Now, watery vapor contains a much larger quantity of latent, or *insensible* heat than liquid water does; consequently, the water taken into the body, being converted into vapor, passes in great part out through the pores, carrying with it the surplus heat. Were it not for these provisions of nature, a man could not exist in an atmosphere having a higher temperature than 100°.

When the skin becomes diseased, the work which it performs is to some extent thrown upon the lungs and kidneys, which are often found unable to accomplish the increased labor, and therefore also become diseased, either in their structures or functions. A common cause of the disordered functions of the skin is inattention to personal cleanliness. If the body be not thoroughly washed, the pores become filled with the saline and semi-organized matters which form the solid constituents of the perspiration. Diminished perspiration produces many kinds of skin diseases, more especially these eruptions termed pimples; and the blood, not being perfectly freed from the effete matters it contains, becomes an unhealthy fluid, and is liable to produce fever and various other maladies. Mere ablution in water is not sufficient to preserve the skin in a healthy state—soap must be liberally employed, so that the fatty exudations from the sebaceous follicles may be dissolved and removed. The scarf skin, undergoing incessant friction, rapidly breaks up into dust, the coarser parts of which are popularly termed "dandriff." This dust also helps to fill up the pores, but it yields to the action of soap, and may to a great extent be got rid of by the use of the flesh brush and coarse towel, or "huckaback." Those who desire a soft, clear, and healthy skin are most likely

to obtain their wishes by washing it as often as possible. The best cosmetic is soft water; and no amount of "complexion restorers" or "Rowland's Kalydor" can compensate for the neglect of ablutions performed with that simple element.

A complete bath should be taken daily, or at least the whole surface of the body should be well sponged with soap and water. A hard white soap, without an excess of alkali, is the best kind to use. Considerable friction may be employed, so as to get rid of the worn out cuticle, and to cause the blood to circulate briskly through the true skin, thereby stimulating its functions. Warm baths cleanse the body better than cold water; but they are not so bracing, and are much better adapted to a state of disease than to that of health. Nothing is more invigorating than the cold bath; but in severe wintry weather, and especially in the case of children and delicate persons, the temperature of the bath may be temperate or nearly tepid. Sea bathing is very invigorating. It promotes appetite, strengthens the muscles, and increases the capability of enduring fatigue. It rarely fails to prove useful in the case of chlorotic girls and scrofulous children. The best time to take a sea bath is when the body is moderately warm; for, if the circulation be feeble, cramps may occur; and if the body be too highly heated, the sudden change of temperature may cause injurious effects. The Turkish bath is admirably adapted for the treatment of various diseases, but only under medical advice; for there are maladies that are aggravated rather than benefited by its use. In health it is found beneficial to most people who use it; but very weakly persons, and those of full habit, should be cautious in exposing themselves to the extreme variation of temperature which distinguishes the Turkish bath. When the perspiration is checked, I know of no method better adapted to restore that function than a Turkish bath; and if the champooing pro-

cess be gone through, the amount of scarf skin removed will prove how thoroughly the sweat ducts have been cleansed. Dr. Edward Smith—one of the most eminent authorities on hygiene—speaks very disparagingly of the Turkish bath, which he says is of but little use, except to those who eat and drink more than they can apply to the use of their bodies. I must confess that those amongst my acquaintances who most frequently take Turkish baths are certainly *bon vivants.*

Clothes are worn not merely through sentiments of decency, but also for the purpose of protecting the body, sometimes from the influence of heat, more frequently from that of cold. The temperature of the blood is maintained at about 99 degs. Fah. by the combustion of tissue, or of food within the body. A naked form exposed to cold air rapidly parts with its heat by *radiation ;* but by interposing between its surface and the atmosphere a *non-conducting* substance, the heat developed within the body is less rapidly given off. In very warm weather clothes protect the body from heat, by *reflecting*, or throwing back, the rays of the sun which fall upon it, and which the unprotected body would otherwise absorb. White garments are best adapted for this purpose, black or dark-colored clothes absorbing the heat rays readily, and also the rays of light, which apparently undergo conversion into heat.

The raw materials from which clothing is made should be light, bad conductors of heat, poros, and durable. Weight for weight, wool is much superior to cotton, and linen is not quite equal to calico, with respect to porosity and heat retention. The texture of woollen cloths can hardly be too fine. A flannel shirt, though perhaps not so pleasant to wear as a soft cotton one, is more healthy; for in winter it keeps the body warmer, and in summer it absorbs the perspiration. I think the Bradford and Hull woollen manufacturers might make a finer and thinner fabric, adapted for inner garments. A mixture of cotton

and wool might be found a good shirting material. In only one respect are cotton and linen superior to wool, and that is, they do not shrink so much under the action of soap and water. Indiarubber clothing prevents the escape of perspiration, and should only be worn during severe weather, and even then not habitually. Coats made from this material should be very wide, and provided with ventilating gussets. No other material is so well adapted for keeping out wet and wind, and its lightness renders it superior to leather, which is so excellent a protection against the influence of rainy and tempestuous weather. The use of Indiarubber overalls is not permitted, on hygienic grounds, in the French army, and they are proscribed amongst the London postmen. Furs are very bad conductors of heat, and are therefore highly prized as clothes in cold and temperate climates.

Comparative heat-retaining power of clothing materials.

Silk twist	81	Silk from the cocoon	128
Cotton wool	104	Beaver fur	130
Unspun wool	112	Eiderdown	130

The results shown in the table were arrived at by determining the time which heated bodies, covered with the different materials, required to cool down to a lower temperature. If a substance covered with cotton wool required 104 seconds to cool it by one degree; then if that substance were covered with an equal weight of eiderdown, it would require 130 seconds to produce an equal cooling effect. Dr. Hammond found that a vessel of water was cooled from 150° to 140° in 7 min. 24 sec. when surrounded with linen shirting, in 9 min. 42 sec. when covered with cotton shirting, in 12 min. 35 sec. with white flannel, in 13 min. 15 sec. with light blue woollen cloth, and in 14 min. 5 sec. with dark blue woollen cloth.

During infancy and childhood nature is less able to resist external influences, therefore young people should

be more warmly clad than adults. No greater mistake can be committed than that of allowing the uncovered limbs of tender infants to be exposed to the piercing blasts of winter, from the absurd notion that the exposure "hardens" them. I have often thought that the mother's heart must be "hardened" too when she could look, unmoved, on the poor little shivering specimens of humanity, returning, with pinched features and purple limbs, from their miserable walk. Is it not almost incredible that parents will insist on exposing their children, half naked, to a temperature which they shrink from encountering themselves, unless when well protected with warm clothing! Scotch soldiers who wear the garb of the Highlanders suffer much from rheumatism, owing to the exposure of their legs to the air; and I believe that the tendency to this disease, which is now so general amongst all classes of society, is to a great extent the result of defective clothing.

Men's clothing at the present time is more natural than women's apparel. Their tall hat is, however, unsightly, and prevents evaporation from the head. It is, nevertheless, a warm covering. Shoes, as a general rule, are worn too tight, and as a necessary consequence, almost every one is troubled with corns, bunions, "irregular toe nails," and even overlapping and disjointed toes. I fear the feet of many beautiful but fashionable ladies would not bear to be investigated from an æsthetical point of view. In order to preserve the natural form of the feet, boots should have low and broad heels, wide toes, and be neither too large nor too small. Hard leather often produces corns. In the act of walking the foot expands from 1-16th to the 1-10th of its length, and its lateral expansion is even greater. The measure of the foot should therefore be taken when the weight of the body rests upon it. In winter both sexes should only use boots provided with thick soles.

Females are often insufficiently clothed. In winter,

the gossamer-like ball-room costume, which leaves the most vital regions of the body exposed, is the cause of many maladies. The excessively small bonnets now worn answer very well in summer, but during cold weather they afford very little protection to the head and neck, and are probably a common cause of neuralgia. Heavy ornaments on the head are injurious; and the prevalent fashion of wearing enormous pads of false hair, to augment the natural size of the *chignon*, is objectionable, for several reasons. Firstly, it is an imposition—a make believe; secondly, it is a useless weight on the head; thirdly, it is liable to be infested with nasty little animals; lastly, it is unsightly, giving a monstrous development to the size of the head. Can you fancy the appearance of a marble Venus with an immense *chignon?*

Stays are almost universally worn in these countries; and if they are properly made and not laced tightly I see no sound physiological objection to their use. Tight stays are more dangerous in the case of girls not fully grown, because the pressure prevents the proper development of the chest, and indeed seriously modifies the anatomy of the whole trunk. The compression of the waist contracts the volume of the lower part of the lungs; the diaphragm is pushed up higher into the chest, the shoulder blades are forced back upon the spine, and the size of the stomach is diminished. The results of these serious malformations are diminished breathing power and impaired digestion. A German physiologist—Soemmering—has enumerated no fewer than ninety-two diseases resulting from tight lacing. The practice of tight lacing is not nearly so prevalent now as formerly; probably because it has been discovered that an excessively small waist is unnatural and unbeautiful.

A crinoline is useful, particularly when the wearer is walking, because it prevents the clothes from clinging too closely to the lower limbs. When it exceeds a very moderate size it is a useless weight hanging from the

waist, it nullifies the protective influence of the clothes outside of it, and it detracts from the pleasing effect usually produced by a tasteful costume. With or without crinoline, very heavy flannel drawers should be worn in winter, and lighter, or calico ones, in summer. Many serious diseases are the result of insufficient underclothing.

The chief points to attend to in clothing the body is to prevent undue pressure upon any portion of it, to have all the vital parts properly covered, and to regulate the amount and quality of the clothing according to the state of the weather.

Every one knows that a certain amount of exercise is beneficial to health. Persons whose occupations compel them to lead sedentary lives are not in general so vigorous or long-lived as those whose pursuits are of an active kind. Exercise promotes rapid metamorphosis of the tissues, and therefore increases the desire for food. It causes a copious exhalation of moisture, which stimulates the functions of the skin. Under its influence the muscles increase in size and power. Dr. Edward Smith has determined the effect of exercise upon respiration. Some of his results are shown in the table.

Table, showing the relative quantities of air breathed by a man under different conditions.

Lying down	100
Sitting	118
Standing	133
Singing, or Reading aloud	126
Walking 1 mile per hour	190
„ 2 miles per hour	276
„ 3 „ „	322
„ 4 „ „	500
Running 6 „ „	700
Rowing	333
Riding (trotting)	405
Swimming	550

Walking in the open air is very healthful, more espe-

cially if the pedestrian select a new route for each ramble. When exercising the body the mind should not, if possible, be allowed to dwell upon the cares and anxieties of business; but it is difficult to accomplish this object if the daily walk reveals nothing new to attract the attention. How different is not the sensation experienced during a saunter by the seaside, through fields, a large park, or even amongst the suburban avenues, with their semi-rural appearance, from the melancholy feeling with which we take a prescribed walk up and down a dull street or round a city square! A walk of twenty miles is equivalent to a day's hard work. Those whose occupations confine them to the house should walk at least three miles daily. The mind and body cannot simultaneously be fully worked; therefore, those whose occupations require a large expenditure of brain power should not take excessive exercise—they should not walk more than five or six miles a day. It is only in walking that women can at all approach men in developing motive power. I have known a small and delicately formed lady to constantly take walks of from twelve to twenty miles without suffering from over-fatigue. This kind of exercise is of so gentle a character that it is peculiarly suited to the weaker sex; and if they take it regularly they will find a decided improvement in health and strength. Pedestrians should not be overclad, nor should their clothes prevent the free play of the muscles. When walking our comfort depends, in no small degree, upon the kind of shoes or boots which we wear. I fear that the vanity which induces people to squeeze their feet into tight boots is a common preventive of healthy exercise. How can a man afflicted with corns or bunions enjoy a walk or a game of cricket?

Swimming, rowing, and riding on horseback are all excellent kinds of exercise; so also would be dancing, were it not usually performed in the vitiated air of the crowded ball-room. The dances termed "fast" are,

indeed, a little too fast; they overheat the body and produce too rapid an acceleration of the heart's action. The old slow waltz and the polka mazurka are, on hygienic grounds, preferable to the *galop*. Gymnastics are now practised in nearly all boys' schools; but they have not come into general use in girls', where they are more required. Boys, during play hours, indulge in various pastimes of an active character; but the outdoor exercise of boarding school girls is too often confined to marching in formal procession, marshalled by a governess, through dull streets or roads. I have already stated that monotonous exercise is the least beneficial, and would strongly urge the necessity for having playgrounds attached to girls' schools. There are excellent games in which girls, and indeed women also, could join, without incurring the charge of unsexing themselves. Croquet is an admirable exercise—not too violent, but just sufficiently active to cause a healthy play of the muscles; besides, it induces the performer to remain in the open air. Every kind of moderate exercise which involves no breach of feminine propriety should be encouraged amongst girls.

Running, leaping, and throwing heavy weights are very severe forms of exercise; and if practised with a view to competition, I doubt if they are not, on the whole, injurious, rather than beneficial. The athletes of ancient Greece and Rome were a very short-lived class; and the same may be said of the modern prizefighters, professional pedestrians, and acrobats. Cricket is a game which does not overstrain the muscles, and I would therefore recommend it before all others; besides, it has the merit of stimulating, in a pleasurable way, the intellectual powers. Rifle shooting is a capital exercise, and so also are nearly all kinds of rural sports. Violent or prolonged exertion of any kind should never be undertaken without previous preparation or training; for otherwise the heart and other muscles might sustain permanent injury.

In training for any kind of severe exercise, great attention must be paid to diet and to the habits of every day life. Early rising, regularity in eating, and perfect cleanliness of the skin are important points. An animal diet is preferable to a vegetable regimen, and the meat should be easily digestible, and not over fat. Starches being somewhat difficult of digestion, should be sparingly used. Alcohol, tobacco, and snuff are inadmissible, but tea and coffee may be used in moderation. A complete bath should be taken at least once a day, and the surface of the skin subjected to friction. Eight hours' sleep will not be too long. Much exercise is not desirable before breakfast, because at that time the stomach is without food; but that meal should be taken as early as possible. Many persons practise severe exercise for a few days or weeks, and then abandon all active habits for perhaps a few months. This is what might be well termed the *intemperance* of exercise. Regularity in the motions of the body, as in everything else, is desirable; and men should always be in sufficient training to enable them to take a long walk or to play a good game of cricket, with the certainty that they would not suffer from muscular pains upon the following day.

A highly nitrogenous diet—chiefly very lean meat—has been recommended as the most suitable during training or when taking great exercise. It would, however, appear from the results of the experiments of Fick and Wislicenus in 1866 that muscular force is chiefly obtained by the oxidation of non-nitrogenous substances. Frankland believes that animal motive power is derived chiefly from starch and the other carbo-hydrates of our food. He admits that some vital energy is developed by the oxidation of albuminous matters, but contends that their chief use is to repair the nitrogenous tissues. Professor Parkes, of Netley, made last year some experiments, the results of which show that during exercise there is a slight decrease in the elimination of effete nitrogen from the body, and after exercise a slight

increase. During action the muscles appear to grow, and take up nitrogen, and, consequently, nervous energy must be mainly derived from the decomposition of the carbo-hydrates, and more especially the fats. Are we to infer from these experimental results that the diet of the athletes, or of hardworking men, should abound in fat rather than in albuminous substances?

It may not be now inappropriate to make a few remarks on the subject of mental exercise. The mind, like the body, can be overworked and underworked. A large class of persons never think of giving their brains a holiday, but work them incessantly, until the springs of life utterly fail. These persons often attain to an advanced age, but I fear that too large a proportion of them prematurely exhaust their intellectual powers. Insanity and paralysis are the most usual results of excessive mental labor. For intellectual workers physical exercise is absolutely necessary, and it should be of that kind which least engages the reflective faculties. Men engaged in office work of a merely routine character may safely play the most scientific game of chess, or read the most ponderous articles in the dryest numbers of the *Quarterly Review;* but for statesmen, over-worked public functionaries, barristers, physicians, and, in a word, all who have hard brain work to perform, the study of "light" literature is the only safe intellectual stimulus. After poring for seven or eight hours over "briefs," long columns of figures, or files of dry business letters, it is much better to read the *Pickwick Papers* or *Handy Andy* than to study Mr. Mills' *Political Economy* or Dr. Whately's *Logic.* Many persons suffer from a terrible disease termed *ennui;* it is produced, so to speak, by *rust* on the brain, and the remedy is obvious. I wish those who abandon themselves to *ennui* could appreciate the maxim, that it is better to wear out than to rust out. The underworked brain becomes the seat of disease, the disuse of the organ leading, I believe, in extreme cases, to dementia and epilepsy.

LECTURE X.—ON THE SANITARY CONDITION OF TOWNS AND DWELLINGS.

To those who have an unlimited choice of residence, I would say—live always in the country, for there mortality is less than in the best quarters of the healthiest city. If, however, inclination or necessity leads you to take up your abode in town, select a dwelling placed under the most healthful conditions possible to be attained. If you can, reside by all means in a cheerful, open suburb; and, if possible, make, by horticultural and other contrivances, your home a real *rus in urbe*. Mortality increases with density of population; therefore, squares and wide streets should be preferred to more confined spaces. The best *aspect* of a house is facing the east, because in the morning the sun's rays penetrate to the front rooms, and in the evening the back apartments are exposed to its cheerful and vivifying influence. The front rooms of a house facing the south are in summer over-warmed with the rays of the sun—which in the meridian attains its highest heating power—whilst the back rooms receive no share of direct sun-light. Many persons never allow the direct rays of the sun to pass into their apartments, dreading its effects upon the colors of their carpets and curtains—thus unconsciously placing more value upon their furniture than upon their health. Dark rooms are more likely to be unwholesome than well-lighted apartments; and it has often been observed that epidemic diseases are most prevalent on the shady sides of streets. Even in sickness, unless under very exceptional circumstances, free exposure to light is desirable—in which opinion, I may add, I differ from many doctors, especially those of the old school.

The site of a dwelling is a matter of great hygienic importance. Damp soils are one of the most common causes of diseases of the respiratory organs, more especially phthisis, or pulmonary consumption. They also give rise to attacks of rheumatism. Dry, impermeable soils are the most healthy; next to those, dry soils that are poros. Low lying situations, especially near the estuaries of rivers, are, as a rule, unhealthy, and persons living in them are peculiarly liable to the ravages of epidemics. During one of the outbreaks of cholera in London the number of deaths per 10,000 persons steadily diminished as the height of the ground increased. At the level of the Thames the deaths were 174 per 10,000; at 10 feet above the surface of the river, 99; at 50 feet elevation, 36; at 100 feet, 20; and at a height of 550 feet, the number of deaths diminished to 6 per 10,000.

The básement story, or ground floor, is always the coldest during the winter—a fact by no means generally known. Sometimes, during very cold weather, the air at the surface of the ground is 20° lower than the air which is only 4 feet higher. Under such circumstances a man's feet would be exposed to a very different temperature from that affecting his head. As a general rule, all low lying places are very cold in winter, and are peculiarly liable to fogs. If your house be situated in a hollow, sleep in the highest rooms of it, for they are the healthiest and warmest.

The high mortality in low lying districts is to a great extent produced by the want of proper drainage; for it is difficult to carry off the sewage of a place which is nearly on a level with the sea. No house can be healthy unless provided with sewers, with every provision for preventing vapors and gases being discharged from them into the atmosphere of or near the house. The effete matters of every kind produced in our dwellings should be removed as expeditiously as possible; and in

towns the simplest and most facile way of conveying the more objectionable portions of the refuse is by water. Mr. Moule's earth closets are well adapted for country houses and villages, but I doubt very much if they will ever be substituted for the humid method of getting rid of the ejestæ of the population now in use in large towns. The main sewer should never run under a house, for should it happen to leak, sad results to the inmates might happen. Typhoid fever has often been termed sewage fever, because it is so frequently produced by emanations from untrapped or leaking house drains. A cesspool in the yard is incomparably superior to a badly constructed sewer beneath the house. Under no circumstances should a sewer trap be placed in the basement story; for, practically, it will be found impossible to prevent fœtid exhalations from forcing their way through it. Large stone sinks are seldom kept in a clean state by servants; in general their utility is more than counterbalanced by the nuisance which they create. Sewer pipes from houses should have a fall of at least 1 foot per 100 feet, and they should have a current of water flowing through them.

One of the essentials of a healthy dwelling is an adequate supply of pure water. I have already dwelt at considerable length upon this subject; but I mention it in this lecture for the purpose of pointing out the connection between bad sewerage and bad water. If you use pump water, you should be careful that it is not contaminated with sewage matters, which have escaped from the drain of your own or your neighbors' houses. Cases of this kind of water contamination frequently come under my notice.

Newly-built houses are not so healthy as are those inhabited for some time. They are damp, and their freshly plastered walls prevent ventilation through the brickwork. If you are obliged to be the first occupant of a house, burn a few tons of coal in it before you

subject yourself to the influence of its humid atmosphere.

Ventilation is a process which should take place unceasingly. Every day the windows and doors of each apartment should be left open for several hours. No room—or even lumber store—should be kept constantly closed. The condition of the sleeping places of servants is much neglected: indeed, the air in them often becomes tainted, and diffuses its noisome qualities throughout the atmosphere of the whole house. Inconsiderate mistresses appear to act on the principle that any place is good enough for a servant to sleep in. If a commission were appointed to inquire into the sleeping accommodation of domestic servants, curious revelations would be the result. The ventilation of bed-rooms is better attended to now than formerly. Until lately it was the fashion to exclude air from them by every possible contrivance. The windows were carefully closed, the door shut, the chimney in summer stopped up, and no openings provided in their place to allow the passage of air. In winter, sand bags were placed at the juncture of the window sashes, and similar contrivances were used to prevent air from passing under the door, or even through the keyhole! The furniture, too, was massive, and encumbered with upholstery. The bed was surrounded with heavy curtains, and covered with a canopy. This style of sleeping apartment is still met with, but far less frequently than formerly. There is now some provision for ventilation; the furniture is lighter and less absorbent, and the hearse-like "four poster" is rapidly being supplanted by the light and uncurtained iron bedsteads.

The dwellings of the lower classes in towns are in general placed under extremely insanitary conditions. The rooms are mostly small, and are over-crowded, in thousands of instances affording only from 100 to 200 cubic feet of space for each inmate. The appliances

for the removal of effete matters are incomplete, and the atmosphere of the place is, therefore, permanently tainted. The houses are too close together; there are either no yards or very small ones; the supply of water is defective—chiefly from the want of vessels to store it in and to apply it; and the rooms and passages, the furniture, clothes, and persons of the inmates are in a chronic state of filth. These sad tenements of humanity are the "fever nests" wherein are hatched the germs of many of the direst diseases that afflict mankind. In improving their condition, we are not performing altogether unselfish labor; for the virus of small-pox or of typhus spreads from the homes of the very poor, and carries death into the mansions of the rich. In Dublin the Corporation are adopting active measures to ameliorate the condition of the abodes of the lower classes; and the model lodging-houses, lately erected by that benevolent association, the Dublin Industrial Tenements' Company, now afford healthful, decent, and cheap dwellings for a large number of the working classes.

Hospitals, barracks, and similar institutions are now constructed on proper sanitary principles. Formerly the converse was the rule, and the mortality within their walls was consequently extremely high. During the first quarter of a century after the establishment of the Dublin Lying-in-Hospital, one out of every seven children born in it died. The cause of this prodigious mortality was found to be the want of proper ventilation, and on remedying the defect the number of deaths immediately fell to 1 in 104. In the dormitories of workhouses and schools there still exists overcrowding and a want of proper ventilation; but, as a general rule, the sanitary conditions of public institutions, where large numbers of people are lodged, are being steadily improved.

In theatres, concert rooms, and other buildings where large numbers of people congregate, the superficial space devoted to each person is rarely sufficient. It is

quite possible to overcrowd a building which, having the sky for its roof, affords to all within its walls unlimited cubic space for breathing in. If people are placed too close together the most perfect appliances for ventilation will not prevent each of them from inspiring the foul air expired from his own and his neighbours' lungs. The owners or managers of all places of public resort should be compelled to provide adequate square as well as cubic space for each person. In the London lodging-houses 30 superficial feet is allowed to each person, and in the section houses of the Metropolitan Police 50 superficial feet. In hospitals each patient should have at least 100 superficial feet.

No house that is not kept thoroughly clean is perfectly healthful. The organic matters thrown off from the body are retained by the carpets, upholstery, and even by the more solid parts of the furniture; they are absorbed by the paper on the walls, and are condensed on the glass of the windows. In bedrooms the less there is to absorb organic matter the better. Carpets look well, but a painted or polished floor is more healthful, so also is one that is covered with oil cloth. Painted walls absorb far less than papered ones, and they admit of being washed. Inferior green paper almost invariably owes its brilliant hue to the presence of arsenic, and should not be used. *Dusting* rooms with a brush is worse than useless, rendering the atmosphere unpleasant and unwholesome for a time, and simply removing the dust from one part of the room or furniture to another. To keep an apartment in a perfectly wholesome condition it must be well aired, well lighted, and well cleaned.

It is a matter of vital importance to the inhabitants of a town that the organic refuse produced in it be removed completely and expeditiously. Before the present century vast quantities of filth were allowed to accumulate in tanks or pits, termed *cesspools;* and whenever the amount of refuse exceeded certain limits, it was removed

by manual and horse labor. The cesspools attached to the houses of the wealthy classes were of course, as a general rule, frequently emptied of their noisome contents, and their condition rendered as innocuous as possible; but it would appear that the majority of town cesspools were much neglected, many of them remaining uncleaned for several years. It can easily be imagined what a bad effect these accumulations of putrifying animal and vegetable matters must have produced upon the health of the inhabitants of towns. They poisoned the atmosphere with fœtid emanations, whilst the overflow or leakage of the liquid contents furnished abundant contributions to the wells. In the country cesspools did not produce anything like the same effect, because they were situated at some distance from the house; but in the crowded cities their deadly vapors could only, in most cases, escape into the atmosphere of the people's dwellings.

About thirty-five years ago the cesspool system began to be superseded by the sewerage system. Each house was provided with a close drain, through which the refuse was discharged into a large street sewer, and by it conveyed to a river or the sea. At first the street sewers were so large that a man could pass through them; but their diameter was gradually reduced, until at length their ordinary size was from 12 to 30 inches. Large drains are found to retain, for a long time, much of the refuse discharged into them, and it is found very difficult to flush them properly.

There can be no question as to the great superiority of the sewerage system as against the cesspool plan; for in every town where it has been adopted the public health has been greatly improved. Dr. Simon, the medical officer of the Privy Council, in his annual report for the year 1866, gives a list of twenty-four English towns, in which, owing to the adoption of the new sewerage system and the improvement of the water supplies,

the death-rate has been diminished from 5 to 50 per cent The sewerage system is, however, open to one great objection—it has converted a large number of rivers into mere sewers, and has greatly injured the riparian fisheries. Owing to the enormous amounts of filth hourly discharged into the Thames, the Liffey, and similarly situated rivers, their waters in many places are simply diluted sewage, from which noxious exhalations are constantly evolved, more especially during warm weather. The condition of the Thames is sometimes almost insufferable; and at the present moment the abominable odor of the Liffey at low water is the subject of general complaint.

The pollution of rivers by town sewage has become a gigantic evil, and imperatively demands a remedy. Attempts—always unsuccessful—have been made to deprive sewage of its solid ingredients before it passed into rivers. Disinfectants have been employed, and with greater success.* I am, however, strongly of opinion that in dealing with sewage pollution, preventive measures alone will prove efficacious. The drainage of towns

* Since this lecture was delivered the effluvia from the Liffey became so intolerable, that the Public Health Committee decided on taking some steps to mitigate, even temporarily, the nuisance. Acting on the recommendation of Dr. Mapother and myself, they caused the foreshores of the river to be treated with the deodorizing and disinfecting compounds prepared by Messrs. M'Dougall, Brothers, of London. The process was carried out as follows:—Sixteen gallons of "patent prepared" carbolic acid and 3 cwt. of "M'Dougall's powder" (a mixture of carbolic and sulphurous acids combined with lime), dissolved in 600 gallons of water, were applied, by means of a hose, to the mud exposed during the recess of the tide. The average width of the river is more than 200 feet, and the length of it treated with the disinfecting materials, 1¼ mile, yet the comparatively small quantity of disinfectants employed sufficed to remove the fœtid odor from the river. The cost of four applications, including labor, horse hire, &c., amounted to only £34. After the fourth application, Mr. Boyle, C.E., secretary to the Public Health Committee, reported that he "could not have believed that such an abatement in the offensive exhalations would have been effected, the trifling amount then remaining being that emitted from the mouths of four or five of the principal sewers."

should not be permitted to convert the pure waters of our rivers into foul and lethal streams. In London this principle is now recognized, and to some extent actually put into practice. The sewage of a large portion of North London is conveyed in close sewers to Barking Creek—a distance of 14 miles—where it is applied to the purpose of fertilizing the soil. Should this experiment prove successful, in both a sanitary and pecuniary sense, one of the greatest and most perplexing social problems of this century will have been solved. The earth, and not the water, is the natural destination of the *ejestæ* of the population; and to use the words of Liebig—"If clearly understood and properly managed, the employment of sewage will prove a blessing to agriculture; and those who, by unwearied perseverance, have at last seen the consummation of their labors may justly be looked upon as the benefactors of their fellow-men."

London is now better provided with sewers than any other large town in the United Kingdom, and the excellence of its provisions for thorough drainage is one of the causes of its comparatively low death-rate. Dublin, until within the last twenty years, was very imperfectly sewered, and so late as a dozen years ago many of its street drains had no outlets; they were, in fact, simply extremely long and shallow cesspools. Since the year 1851, 40 miles of new sewers have been laid down, and 11 miles of old drains reconstructed, under the direction of the city engineer, Mr. Parke Neville. As there are 110 miles of roadway within the city, there still remains 59 miles of sewers to be laid down; but the work is going on rapidly, and when completed, this city will not be inferior to any in the world, so far as its sewerage system is concerned. Indeed, nearly all the important streets are now drained, and the remaining roadway is chiefly stable lanes, or is unbuilt upon, and will probably never require main sewers.

Before the practice of intramural interments was prohibited by the Legislature, the condition of many of the burial places in towns was shocking in the extreme. So numerous had been the interments in some of the London churchyards, that the surface soil was almost wholly composed of human remains. According to the present state of the law, no interment can take place within two miles of the metropolis. In Dublin intramural burials are very rare. There are three cemeteries situated in the immediate vicinity of the city, and every precaution is adopted to prevent them from polluting the atmosphere. I wish I could speak so favorably of the state of the burial places in other parts of Ireland; but, unfortunately, many of them—especially in the smaller towns—are in a most neglected condition. I have seen graveyards where the relics of poor mortality met the eye in every direction, and where two or three inches of clay were considered a sufficient covering for the last tenement of the dead. Amongst the French, thoughtless and frivolous as we believe them to be, the feeling of respect for the dead is profound. There are few Frenchmen or Frenchwomen who do not, if possible, pay periodical visits to the graves of their departed relations, and renew the withered wreaths of *immortelles* on their tombs. The cemeteries of France are always neatly kept, and the graves preserved from the inroads of weeds. As for us, with few exceptions, we never visit the last resting places of our deceased relatives; and the graveyards are, perhaps, the most neglected spots to be found in these countries. A movement has recently been initiated, with the view of converting city graveyards into neatly kept, well planted, and easily accessible grounds to the public. Such places are hardly suitable for parks or children's play grounds; but any step that would divest them of their wilderness-like appearance and insanitary condition would be most beneficial to the health of those who reside near to them.

LECTURE XI.—ON CONTAGION AND DISINFECTION.

Most of the diseases which affect mankind arise spontaneously in each individual, and are not communicable from one person to another; but some of them are propagated from the sick to the healthy. Any one completely isolated—that is, separated from contact or communication of any kind with all other persons—may still contract bronchitis, inflammation of the lungs, or paralysis; but a man so circumstanced would not be liable to small-pox, Asiatic cholera, or typhus fever. Diseases that arise spontaneously are termed *sporadic;* those which are acquired by contact with the persons of, or emanations from, the sick are called *contagious*. Contagious diseases are in general epidemics—that is, they simultaneously attack a large number of persons; but it is probable that a few non-contagious maladies are also epidemics; in this class influenza is placed by some writers. The terms contagious and infectious are now generally used indifferently, and are equivalent to the expressive word *catching*. The term *endemic* is restricted to certain diseases, the range of which is confined to particular localities. Goitre, for example, is endemic in the Swiss valleys, *malaria* in the Roman plains, and ague in the marshy districts of India. All the diseases which appear in the epidemic form, or which are supposed to be contagious, are now generally placed in a group, and termed *zymotics*. Diseases of the same general nature, which affect the lower animals, are called *epizoötics*. Every zymotic complaint must, of course, have had a spontaneous origin at some time; but the extraordinary combination of circumstances

which produce a new disease are of extremely rare occurrence. There is but little doubt that small-pox, once annihilated, would never reappear.

The indirect causes of zymotic diseases are, unfortunately, almost completely unknown; but an opinion prevails amongst epidemologists that cholera, small-pox, fevers, and similar diseases are the results of the introduction into the body of specific poisons or ferments. Pathologists, naturalists, microscopists, and chemists have sedulously endeavoured to discover the virus, or germs which cause disease, but with scant success. Dr. Beale employed in researches of this kind a microscope which magnified so immensely that, were it possible to look through it at a man, he would appear to be twice the height of Mont Blanc; yet with this powerful instrument the only abnormal appearance which could be perceived in the blood of oxen affected with rinderpest (a deadly epizoötic) was a little granular matter. Professor Hallier, of Jena, has apparently been more successful; for he states that he has discovered what appears to him to be the virus, or *materies morbi*, of Asiatic cholera. In 1866 this eminent mycologist found that the fluid obtained from cholera patients contained large numbers of minute fungi (the lowest forms of vegetation), and their *spores*, or seeds. He experimented with these cholera fungi—if they may be so termed—and found that they propagated with extreme rapidity, and quickly disorganized muscular tissue and pieces of intestine on which they were placed. These fungi were found to require a higher temperature for their perfect development than that of the atmosphere of Germany; hence it was concluded that they were indigenous to some such climate as that of India, and were at least totally distinct from all European fungi. These investigations are of the highest importance; because, if the conclusions evolved from their results be correct, cholera is produced by the introduction of a fungus into the body. Halleir recalls to recollection the fact, that

English physicians at first termed cholera the rice disease, because it appeared to be produced by the use of that food in a *blighted*, or diseased state. Are we to infer, then, that a fungoid growth on rice is the cause of cholera? Halleir thinks so, and has succeeded in engrafting the fungi which he obtained from cholera patients on rice grown under conditions as nearly as possible to those under which that plant is cultivated in the East. In India—the home of the cholera—the rice fungus is the primary cause of the disease, and, preserved by the high temperature of the bodies of men, it is conveyed to all parts of the world. In cold countries, nevertheless, these fungi gradually perish in their transmission from one person to another. Dr. Thomé, of Cologne, and Professor Klob, of Vienna, have also recently announced their discovery of minute fungi in the stomach and intestines of cholera patients. These little organisms multiply rapidly, and on leaving the body appear to be endowed with the power of communicating the disease, if reabsorbed by healthy persons.

In the present condition of medical science it seems most rational to assume that the direct cause of every kind of zymotic disease is a distinct organized body, or entity, and not mere abnormal conditions of the ordinary ingredients of the air or soil. The more important zymotic diseases are small-pox (their type), the various fevers, measles, scarlatina, diphtheria, whooping-cough, Asiatic cholera, and probably diarrhœa. It is a singular fact, that persons who have once suffered from a zymotic disease rarely contract the same malady a second time. It is supposed that the blood of every person contains a peculiar principle, on which the virus of the disease alone subsists, so to speak, and that when this substance becomes exhausted during an attack of the malady, it is not again renewed. This hypothesis is not supported by any proofs, and is far from satisfactory, but no more probable theory has been suggested. Another fact in

relation to zymotics has also been established, and that is, that all persons are not equally susceptible to their influence. Many medical men have been for years engaged in the treatment of fever, and yet have escaped that malady, while thousands of persons have caught the disease at their first contact with a fever patient. *Susseptivity* to contract zymotic diseases is produced by intemperance, by insufficient nutriment, by the habitual respiration of bad air—in a word, by every cause that lowers the vital powers.

According to Professor Von Pettenkofer, three conditions are usually present, in order to produce cholera: firstly, the actual germ of the disease; secondly, a peculiar state of the soil, which favors its development, and accounts for its presence; and, thirdly, a natural tendency, or *receptivity* in the individual to absorb the poison. When cholera is epidemic its contagium is diffused throughout drainage water, which conveys it into the wells and rivers, and into the soils beneath our houses. According to Pettenkofer's theory, loose, poros soils are most dangerous during outbreaks of cholera, because they afford a ready passage to the infected drainage. During the last epidemic East London suffered terribly; yet in the Limehouse school for children, situated in the heart of the district, not one of the 400 inmates caught the disease. This institution is built on a little island of stiff, impertransible clay, surrounded on all sides by poros gravel; and to this circumstance, Dr. Sanderson, adopting Pettenkofer's views, attributes the immunity of the children from the disease. Pettenkofer's theory is strengthened by some remarkable observations made by Dr. Mapother. On consulting some old maps of Dublin, he found the sites of long forgotten watercourses—now the channels of sewers, or filled up with mud—and ascertained that three-fourths of the cases of cholera which occurred in 1866 were over, or close to, these disused watercourses.

Those who feel interested in the history of the last outbreak of cholera in Dublin will find it exhaustively treated in a paper by Dr. Thomas Haydens and 'Dr. Cruise, in the Dublin Quarterly Journal of Medical Science for May, 1867, or in a reprint of this paper, published by Fannin and Co., of Grafton-street.

Zymotic diseases are termed preventible, because the causes which produce them are removable by sanitary means. The great hygienic agents are vaccination, ventilation, good sewerage, pure water supplies, cleanliness, and disinfection.

On the 14th May, 1796, the immortal Jenner established the fact, that by inducing in the human subject an attack of a mild disease, termed cow-pox, immunity might be secured against small-pox, a much more dangerous malady. This great discovery has conferred the most important and lasting benefits upon the human race; and but for official supineness would long since have extirpated one of the most fatal and loathsome diseases which afflict mankind. In the early part of the present century small-pox was one of the most commonly occurring diseases. In 1838, no fewer than 16,268 persons died from it in England. Since that time, owing to vaccination, small-pox has gradually declined, but in 1865 the deaths from it still numbered 6,411. In Ireland, owing to the admirable manner in which the Poor-law medical officers perform their functions as public vaccinators, small-pox has been literally "stamped out." In the decade ended in the year 1841, no fewer than 58,006 persons died in Ireland from small-pox, and many thousands suffered disfigurement. During the next ten years the number of fatal cases of the disease fell to 38,275; and from 1851 to 1861 the number decreased to 12,727. In 1866 187 deaths occurred; and last year only 20 persons fell victims to this disease. During the current year I believe no cases of small-pox have occurred in our country. In some parts of the

world, where proper preventive measures are not adopted, small-pox still largely prevails; but in other places—the Grand Duchy of Baden, for example—strict attention to vaccination has completely eradicated the disease. In some armies re-vaccination is performed on the soldiers, and with excellent results. Vaccination of adults, even in those cases where the operation had been successfully performed in infancy, is strongly recommended by many medical men. An Act of Parliament, passed in the year 1864, renders vaccination compulsory. The pernicious practice of *inoculation* with the virus of small-pox is prohibited by law; but I fear it still prevails amongst the lower classes of England: it was, until very lately, a common cause of death by small-pox in Ireland.

What has been done in Ireland in the case of small-pox might also be accomplished with respect to most, if not all, of the other zymotic diseases, though no doubt with more difficulty. There can be no question now as to the geographical origin and pathways of cholera, and surely something might be done to arrest its progress from India or Arabia to Europe? To establish a strict quarantine in the immense number of British ports would seem too costly, and perhaps too impracticable, an operation to be undertaken; but all Europe combined might be able to organize some system which would prevent the entry of cholera into Europe from the East.

Filth is a prolific source of almost all kinds of diseases, and is the chief carrier of contagia. No town, no house, no man, can remain unclean, and be healthy. The animal poisons which produce disease are thrown off from the bodies of the sick, and if not speedily got rid of, are likely to be absorbed into the blood of healthy persons. If houses are not provided with the means for safely and expeditiously removing the filth produced in them, the health of their inhabitants and of the whole neighbourhood suffers from the noisome exhalations. When fever occurs in a house unprovided with a sewer or ash-bin—a

case by no means unfrequent—it is easy to predict what follows: the refuse of the dwelling (including the matters thrown off from the patient) is necessarily flung into the street, where, in dry weather, it is partly converted into dust, and the contagium of the disease is wafted by the winds into houses hundreds of yards distant. Perchance the refuse is thrown into the yard or garden, in which case the rain washes the contagium into the soil, and the drainage water conveys it to the nearest well. Were it not for the wonderful disinfecting powers possessed by the atmosphere and the soil, the spread of animal poisons by air and drainage water would be almost infinitely greater: we should, however, aid nature in her work of destroying the baneful matters that poison the springs of health and longevity.

A great variety of substances, termed *disinfectants*, are used for the purpose of purifying air and water, and for rendering innocuous sewage and other refuse matters. During outbreaks of cholera and fever they have, in general, been found most efficacious in arresting the progress of the disease; but as they have in a few instances failed in producing any apparent effect, they should not be too much relied upon, nor substituted for thorough ventilation, proper drainage, and perfect cleanliness. Disinfectants are useful even in the absence of epidemics; and by daily employing them the sanitary condition of a house could hardly fail to be improved.

There are three powerful gaseous disinfectants—chlorine, sulphurous acid, and nitrous acid. Chlorine, free, or combined with lime (bleaching powder, or chloride of lime), is the most frequently employed; it may be prepared by gently heating a mixture of 4 parts, by weight, of strong muriatic acid, and 1 part of black oxide of manganese. Chlorine is a heavy, yellowish green gas, and possesses a powerful odor; when breathed, even in a diluted state, it acts injuriously on the respiratory organs, and induces violent coughing. This gas instantly

decomposes sulphuretted hydrogen and phosphuretted hydrogen gases, abstracting their hydrogen, with which it forms muriatic acid. Its action upon organic matters is less rapid, and appears to be indirect—that is, it first decomposes water, and uniting with the hydrogen of that fluid, throws the oxygen of it, in a condensed state, upon the organic matters, which are then oxidized. In some cases chlorine probably mineralizes organic matters by directly abstracting their hydrogen.

Sulphurous acid is readily prepared by burning sulphur on red hot coal, or in a pipkin, heated to incandescence. It rapidly oxidizes organic matter; and some of its salts —to one of which, the bisulphite of lime, I have already referred—act as powerful deodorants.

Nitrous acid is apparently the most powerful of the gaseous or vaporous disinfectants. It is evolved in the shape of yellowish red fumes when copper wires or filings are placed in nitric acid and a little water. The vapors of this acid are very irritating to the lungs.

Hypochlorous acid is set free when sulphuric acid is poured on bleaching powder. Its action resembles that of chlorine, but its preparation is more simple.

The gaseous disinfectants are best adapted for the purification of air. Every room in which there had been a case of scarlatina, whooping-cough, or other contagious disease should be disinfected. I will describe this operation. The furniture is removed, the walls denuded of their paper covering, the windows closed, and the chimney stopped up. The disinfecting agent is then set free, the operator instantly retiring and carefully closing the door. After 24 hours the windows and doors are thrown open, and a free current of air established through the room. In a few days afterwards the walls may be re-papered, the ceiling whitened, and the floor well scoured with water and carbolic acid soap. Half a pound of bleaching powder, four ounces of sulphuric acid, and a little water are about the quantities necessary to disin-

fect a good sized room. It is *safer* to use more than one of the gaseous disinfectants, and *safest* to employ the three of them—but, of course, not simultaneously.

For the disinfection of sewage and refuse receptacles of all kinds a great variety of chemical agents are employed. Sulphate of iron, or copperas, is a very cheap one: one pound of this salt, dissolved in a gallon of hot water, forms an excellent application to sewage, removing the bad odor, and preventing the development of low forms of life. Perchloride of iron, chloride of manganese, chloride of zinc (Burnett's fluid), sulphate of zinc, sulphate of copper, and nitrate of lead resemble copperas in their action upon sewage, but they are more expensive, and perhaps not much more efficacious. Chloride of lime is also used to deodorize sewage. Quicklime, if used for this purpose, must be applied before the sewage or refuse is in a state of decomposition; otherwise it causes an evolution of ammonia. Permanganate of potash (Condy's solution) is an extremely powerful disinfectant, but its high price almost limits its employment to the purification of potable water. I believe, however, it has also been recently successfully used in deodorizing bilge water in French war vessels.

Carbolic acid—a product of the distillation of tar—is employed more extensively than other substances for disinfecting purposes. It does not destroy organic matters, neither does it prevent them from being gradually oxidized, but it completely arrests fermentation. Animal or vegetable substances in a state of putrefaction evolve unwholesome vapors and gases; any agent, therefore, that arrests or prevents that condition must be regarded as a disinfectant. Putrescent organic matter teems with low forms of life, which some authorities regard as the causes of specific diseases. Carbolic acid prevents the development of these organizms, or destroys them where they have already been produced. "M'Dougall's powder" is composed of a mixture of

carbolates of lime and magnesia, and sulphites of lime and magnesia. It combines in itself the oxidizing power of sulphurous acid and the antiseptic properties of carbolic acid. It is used in the treatment of town sewage, and for the disinfection of house drains, cesspools, ash-pits, and all places where organic matter is likely to be decomposed. During the recent epidemic of cholera in Dublin the streets were watered and the sewers flushed with a very dilute solution of carbolic acid. So powerful is the action of "M'Dougall's powder" that one part of it has been found to perfectly deodorize 100,000 parts of foul sewage. No house should be without a supply of this cheap disinfectant; and it may be daily poured into the drains and other places where refuse matter is deposited.

Charcoal is an excellent deodorizer. It absorbs into its pores foul gases and vapors, where they are oxidized and rendered harmless. Earth is also a good oxidizing material, and has the advantage of being very cheap.

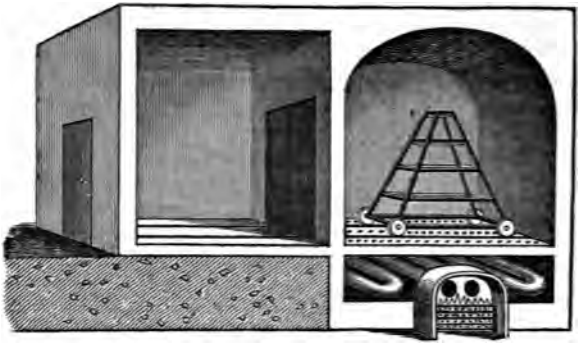
The clothes which have been worn by persons affected with contagious diseases are best destroyed; for they have been known to retain the contagium even after being washed in boiling water. Air heated to 280° does not injure clothes, but it completely destroys insects, fungi, and animal poisons. Highly heated air may, therefore, be regarded as one of the safest and most powerful disinfecting agencies. The Corporation of Dublin have constructed, at a cost of £400, a hot-air chamber, in which clothes and bedding are disinfected for the public, the fees charged for the operation being little more than nominal.* Its construction is shown in the diagram.

---

* *Charges for disinfecting articles at the hot-air chamber.*

Per day of 9 hours, at disinfecting temperature (300°)	8s.
Per period of 5 hours, ditto	5s.

(These charges include coals and attendance.)



The walls and ceiling of the compartment in which the clothes are heated are built of brick, and its floor is composed of perforated iron plate. The heat is supplied from the exterior surface of a coil of pipe, 80 feet in length, which acts as part of the furnace flue. The products of combustion escape into the atmosphere without passing into the close chamber, and no emanations from the infected clothes can pass into the open air; this disinfecting apparatus cannot, therefore, in any way

		d.
Disinfecting	single blankets, each	1
„	per pair or double	1½
„	rugs, each	1½
„	quilts, each	1
„	sheets, pair	1
„	bed ticks, each	1
„	pillow cases, pair	½
„	great coats	2
„	body coats	1½
„	trowsers	1
„	smaller articles, dozen	6
„	shawl	1½
„	hearth rug	2
„	carpets, dozen yards	3
„	curtains, pair	2

Articles belonging to the poor are disinfected gratuitously, if ordered by medical or relieving officers.

taint the atmosphere of the locality. This useful apparatus was first, in 1866, and during the prevalence of cholera, set up in Fishamble-street; but, owing to a groundless panic amongst the inhabitants of that locality, who imagined that the chamber would spread the cholera amongst them, the Corporation were induced to remove it to its present rather inconvenient situation in Marrowbone-lane.

LECTURE XII.—ON VITAL STATISTICS AND SANITARY ORGANIZATIONS.

Very few people die from old age, yet that is the natural termination of man's life. In the mortality returns a small proportion of the deaths is officially ascribed to "accident;" but the great majority of deaths really result from accidental causes. If a strong and healthy man be poisoned with sewer emanations, and die from typhoid fever, surely that circumstance would be an accident! If you neglect to have your child vaccinated, and it subsequently perishes from small-pox, would not its death be the result of accident—one, too, that might have been easily prevented? Every death from a preventible disease is an accident, and not a natural and inevitable event. Nor are the maladies termed "constitutional" necessarily inherent in man's nature: most of them are the results of privation, hardship, intemperance, gluttony, and immorality. Many of them are produced by breathing bad air and drinking foul water. They not only originate in our own faults and misfortunes, but we also inherit them from our ancestors; for the effects of the sins and mishaps of men do in verity descend upon their children "even unto the third and fourth generation."

Vital statistics are useful, because we learn from them the mortality caused by each disease, and the duration of human life under different conditions. Without their aid there could, in fact, be no state, or political medicine worthy of the name of science. It is, however, to be feared that in Ireland this class of statistics is not collected with that degree of accuracy which such investigations require in order to render their results really valuable. Such figures as are submitted to the Registrar-

General are carefully considered, arranged, and certain conclusions evolved from them by Doctor M. Burke, the able Medical Registrar, and his painstaking assistant, Mr. J. J. Wilson. But these gentlemen—to whom I fear I too often prove a troublesome querist—can only deal with the figures supplied to them; and if these be incorrect, then the deductions from them must also be inexact. It is well known that all the deaths and births that occur in a district are not registered. For example, could any statistics be more unreliable than those furnished by the Connaught registrars, from which it would appear as if only one person out of every 81.5 died during the year 1867? If we inferred from these statistics that the average age at which people in Connaught died was nearly 82 years, I think we should form a very erroneous estimate of human longevity in that province.

Neglect to register a death is punishable, but who ever hears of convictions for such omissions? The registrar is in general the dispensary doctor of the district, and for each record of a death he receives the trifling sum of one shilling. Under such a feeble stimulus he can hardly feel sufficient interest to inquire whether or not unregistered deaths have taken place in his district. In order to obtain a really accurate account of the number of deaths, their causes, and the ages of the deceased individuals, the collection of vital statistics must be much more vigorously undertaken. It is hardly possible that a death and interment could occur without attracting the attention of the police; they should, therefore, receive instruction to promptly report every case of the kind to the registrar. It should be rendered incumbent on every undertaker or coffin maker to report to the registrar or to the police every funeral in which he was concerned, and similar information should be communicated by the persons having charge of burial places. I understand that at present the registrars cannot obtain any information

of this kind from the officials of one of the large cemeteries near Dublin. The fee paid to the registrar should be increased, as the present paltry sum hardly pays for the scrivenery of the transaction.

It is obvious that if vital statistics are worth collecting at all, every reasonable precaution should be adopted to ensure their accuracy. It is quite evident that the present system of death registration is, to a great extent, and more particularly in country districts, a failure—a waste of public money. If these propositions be admitted, one of two alternatives ought to be promptly selected—either to abandon the collection of vital statistics, or to adopt a new and reliable method of ascertaining the actual number of deaths. To me it appears evident that no satisfactory results will flow from any system of registration that is not exclusively managed by medical men. The duty of recording the births and deaths—I will say nothing of the marriages—should be entrusted to the Poor-law medical officers; who, in return for their monopoly of this function, should be obliged to perform their work in a manner that would ensure its results being valuable to statistical and sanitary science. To any one who appreciates the advantages derivable from the study of accurate vital statistics, the peculiar fitness of physicians for the office of registrars of births and deaths is obvious. They would not commit the mistakes in the nomenclature of disease which the non-medical registrars sometimes make, thereby rendering their returns worse than useless. They alone would be able to indicate the causes of an unusual amount of mortality in their districts. As they constitute more than a third of the whole body of medical practitioners, and undoubtedly have charge of more than two-thirds of the sick, they have themselves the opportunity of ascertaining, personally, a large, if not the largest, proportion of the deaths occurring in their districts.

I am quite satisfied that it is in the power of the dis-

pensary physicians, who are also the registrars of deaths and births, to enlarge our knowledge of the etiology of disease—the first step towards its prevention or cure. We have a great deal to learn, not only relative to the ills which flesh is heir to, but to the flesh itself. Why is it that a disease extinguishes the spark of life in one man, deals gently with another, and passes by a third? I believe that the causes of death are seldom simple, and that in the majority of cases it is a bad constitution (*diathesis*), and not his malady, that kills the sick man. No doubt, it is useful to learn how many members of the community die annually from consumption; but the information would be far more valuable if it were known in how many cases the disease was the result of following an injurious trade, or of living upon a damp soil—whether it was produced from a direct cause, or was the result, mediate or immediate, of a constitutional tendency to phthisis. In short, the object for which vital statistics are collected would be more likely to be achieved if accurate information were obtained relative to the causes, proximate and remote, of deaths. Perhaps it would not be found impracticable to fill up some such form as that shown in the diagram.

Particulars to be stated in Form for Registration of Death.

Name—Age—Bachelor, Married, or Widower—Birth-place — Diathesis — Occupation—Climatic and Telluric Conditions of Residence and Place of Business—Ages at, and Diseases of, which his relatives of the first degree had died—Disease or Diseases which directly or indirectly caused the death.

It is, of course, not to be expected that so comprehensive a form as this is would, in the majority of cases, be filled up satisfactorily; but I am confident that the adoption of some such form of death registration would

be the means of accumulating a mass of valuable medical statistics for the purposes of public hygiene.

Table showing the number of Births registered in Ireland during the year 1867.

Registration Province	1st Quarter.	2nd Quarter.	3rd Quarter.	4th Quarter.	Whole Year.	Ratio of Birth. to Populations
Leinster ...	8,097	9,231	7,845	6,930	32,103	1 in 44.5
Munster ...	10,342	11,027	9,078	8,254	38,701	" 39.5
Ulster ...	13,041	14,079	11,979	11,625	50,724	" 38.1
Connaught	6,072	5,702	5,346	5,670	22,790	" 39.9
Total ...	37,552	40,039	34,248	32,479	144,318	1 in 40.2

In 1864 the number of children born afforded a ratio of 1 in 42.4 of the inhabitants; in 1865, 1 in 39.9; and in 1866, 1 in 39.7.

Table showing the number of Deaths registered in Ireland during the year 1867.

	1st Quarter.	2nd Quarter.	3rd Quarter.	4th Quarter.	Whole Year.	Ratio of Deaths to Population.
Leinster ...	8,934	6,950	5,593	6,060	27,537	1 in 51.9
Munster ...	8,181	6,470	4,753	5,563	24,967	" 61.2
Ulster ...	9,703	7,908	6,008	6,643	30,262	" 63.8
Connaught	3,638	2,906	2,195	2,406	11,145	" 81.5
	30,456	24,234	18,549	20,072	93,911	1 in 61.7

Annual Rates of Births and Deaths per 1,000 *Persons living in England and Wales.*

	1862.	1863.	1864.	1865.	1866.	1867.	Mean '62-'67
Births	35.04	35.39	35.64	35.64	35.54	35.84	35.08
Deaths	21.47	23.05	23.86	23.39	23.61	21.98	22.57

In 198 districts, comprising the chief towns, and containing a population of 11,000,000, the average death rate in 1867 was 23.89 per 1000 persons living. The average for the years 1858 to 1867 was 24.56.

In the remaining districts, embracing the small towns

and country parishes, and containing a population (in 1861) of 9,135,383, the rate of mortality in 1867 was 19.55, and in the period 1858–1867, 20.08 in every 1000 persons living.

Annual Numbers of Births and Deaths per 1000 persons living in Scotland.

	1867.	1866.	1865.	1864.
Births	35.9	36.	36.	36.
Deaths	21.4	22.6	22.5	23.8

In every 1,000 deaths in England and Wales that occurred in 1865, no fewer than 235 were ascribed to zymotic diseases; 381 perished from local maladies—inflammations and functional diseases of the heart, lungs, and other organs; 182 died from "constitutional diseases," such as phthisis, gout, and dropsy; 160—chiefly children and aged persons—were carried off by developmental diseases, such as debility; and 36 met violent deaths. In 6 deaths per 1,000 the causes were not stated. Half of the number of deaths of young women between the ages of 20 and 30 years is caused by consumption. In some parts of England the death rate is so low as 15 per 1,000 living; in others it rises to from 30 to 70.

According to Mr. Ratcliffe, rural laborers, aged 20 years, have on the average 45.32 years to live; carpenters, 45.28 years; domestic servants, 42.03 years; sawyers, 42.02 years; bakers, 41.92 years; shoemakers, 40.87 years; weavers, 41.92 years; tailors, 39.40 years; hatters, 38.91 years; stone masons, 38.19 years; plumbers, 38.13 years; mill operatives, 38.09 years; blacksmiths, 37.96 years; bricklayers, 37.70 years; printers, 36.66 years; clerks, 34.99 years; population of England and Wales, 39.88 years. The relative mortality in these trades is not constant at all ages; for example, a printer at 60 years of age has a mean

expectancy of 12.04 years; whilst, at the same age, a bricklayer's expectancy of life is only 8.44 years. As a general rule, the average relative mortality amongst persons following different pursuits is very closely maintained at all periods of life.

Table showing Expectation of Life at different Ages, in a Healthy District (Farr, 1859*):—*

Age (or past-life-time).	MALES.		FEMALES.	
	Mean after-lifetime of males of the age x.	Mean age at death of males actually living of the age x.	Mean after-lifetime of females of the age x.	Mean age at death of females actually living at the age x.
0	48.56	48.56	49.45	49.45
5	54.39	59.39	53.93	58.93
10	51.28	61.28	50.88	60.88
15	47.20	62.20	47.04	62.04
20	43.40	63.40	43.50	63.50
25	39.93	64.93	40.18	65.18
30	36.45	66.45	36.35	66.85
35	32.90	67.90	33.46	68.46
40	29.29	69.29	30.00	70.00
45	25.65	70.65	26.46	71.46
50	22.03	72.03	22.87	72.87
55	18.49	73.49	19.24	74.24
60	15.06	75.06	15.69	75.69
65	12.00	77.00	12.58	77.58
70	9.37	79.37	9.85	79.85
75	7.15	82.15	7.52	82.52
80	5.37	85.37	5.64	85.64
85	4.01	89.01	4.19	89.19
90	2.99	92.99	3.11	93.11
95	2.25	97.25	2.32	97.32
100	1.69	101.69	1.75	101.75

Mr. Neison states that persons of intemperate habits, aged 20 years, live on the average to be 35½ years; and if they are 30 years, their mean expectation of life is 13.80 years. He calculates that the average duration of life

after the commencement of intemperate habits is 21.7 years amongst the beer drinkers, and 16.7 years amongst the spirit drinkers.

M. Quetelet, the eminent Belgian statistician, presented a valuable report on the vital statistics of European countries to the statistical congress who assembled at Florence last year. In the table I give a statement of the birth and death rates in various States, arranged from Quetelet's report.

Table showing the Number of Births and Deaths in every 10,000 *Inhabitants of Foreign Countries.*

	Births.	Deaths.		Births.	Deaths.
France ...	255	... 232	Norway ...	330	... 174
Belgium ...	303	... 226	Spain ...	366	.. 276
Hanover ...	304	... 227	Austria ...	369	... 275
Bavaria ...	325	... 281	Wurtemburg	369	...
Sweden ...	326	... 210	Prussia ...	398	.. 262
Holland ...	327	... 247	Saxony ...	412	... 278
Denmark ...	329	... 214	Russia ...	412	... 274

An official document recently published gives revised statistics of several States, for the year 1865. They are shown in the table.

	Estimated Population in 1865.	In every 10,000 inhabitants in 1865.		
		Marriages.	Births.	Deaths.
United Kingdom...	29,768,000	84	356	231
France	37,981,000	79	265	242
Austria... ...	34,676,000	80	391	310
Italy	22,484,000	92	385	299
Spain	16,379,000	—	375	329

The number of births officially recorded in the Dublin registration district during the year 1867 was 8,241, being in the ratio of 1 to every 38, or 26 per 1,000 of

the population in 1861. In that year the city and certain of its suburbs included in the registration district contained 314,409 inhabitants—a number which in all probability increased to 320,000 in 1867.

Last year the number of deaths registered in the Dublin district amounted to 8,607, being 1 in every 37 persons living, or in the ratio of 27 in every 1,000 of the population in 1861. Of these deaths, 2 out of every 9 were caused by zymotic, or preventible diseases; and 5 out of every 41 were ascribed to phthisis, or pulmonary consumption. Very nearly one-third (32.5 per cent.) of the persons who died were under 5 years of age;* 5.1 per cent. were between 5 and 10 years of age; 4.8 per cent. between 10 and 20; 16.3 per cent. between 20 and 40; 18.1 per cent. between 40 and 60; 19.5 per cent. between 60 and 80; and 3.6 were 80 years of age and older. In only 1 death in every 1,000 the age was not specified.

In the suburban districts the death rate varied from 1 in 41 in Donnybrook, to 1 in 67 in Kingstown. Within the city, 1 in every 34 persons died on the north side, and 1 in 35 on the south side. No fewer than 31 out of every 100 deaths occurred in the hospitals, workhouses, lunatic asylums, and prisons.

Dublin has a high death rate, and the number of births in it is less than that of the deaths. No doubt, all the births are not registered, but neither are all the deaths; and, therefore, we may safely assume that though not absolutely correct, the registration of births and deaths affords pretty accurate relative data from which we can determine whether or not the population of Dublin is increasing by means of an excess of births over deaths. Now, it is quite evident from the registration returns that the increase in the population of

* The causes of the excessive mortality of infants is luminously treated in Dr. William Moore's pamphlet on the subject, published in 1861 by Fannin & Co., Dublin.

Dublin is solely due to an influx of persons from other places. I am not aware that Dr. Malthus's doctrines prevail amongst the citizens of Dublin; and I, therefore, conclude that it is solely the insanitary condition of this city which prevents a natural increase in the number of its inhabitants.

Although the mortuary returns of the city of Dublin are now so unfavorable, I believe that the sanitary condition of the city has been improved within the last twenty years. Before the year 1848 there was no legal sanitary organisation in Dublin, except the police force, instituted ten years previously, and who only interfered to prevent the more glaring nuisances. In 1848 a voluntary Sanitary Association was established under the presidency of Sir Edward Borough. They met regularly for several years, and helped on the good work of sanitary reform—as did also another voluntary sanitary body, under the guidance of Dr. Wharton, but whose operations were limited to St. Peter's parish. In September, 1848, the Nuisances Removal and Diseases Prevention Act was passed, and in the same month and year the Corporation of Dublin appointed a committee of their body to carry the Act into effect. The Commissioners of Police appointed four constables to act as Nuisance Inspectors, under the directions of the committee; and a Sanitary Court of Borough Magistrates was constituted. This tribunal proved most useful; but it ceased to exist in 1851, a doubt having arisen as to the legality of its constitution. At the present time the Corporation possess considerable sanitary powers, vested in them by the Dublin Improvement Acts of 1849, 1851, and 1864; the Towns Improvement Act, 1854; the Burial Grounds (Ireland) Act, 1856; the Adulteration of Food Prevention Act, 1860; the Bakehouse Regulation Act, 1863; the Nuisances Removal (Amended) Act, 1863; the Sewage Utilization Act, 1863; the Sanitary Act, 1866; and the Workshops Regulation Act, 1867.

Up to 1866 the sanitary powers possessed by the Corporation were wielded by "No. 2 Committee," who had also charge of the markets. The sanitary staff consisted of the Secretary, Sir Drury Jones Dickinson—who had, however, numerous other duties to perform—and two inspectors of nuisances. In 1862 a city analyst was appointed; two years later Dr. Mapother was elected medical officer of health, and shortly after that event the sanitary department of the Corporation was completely re-organised. At present the charge of sanitary matters devolves upon the "Public Health Committee." Of the labors of this body I could hardly speak in terms too laudatory. Four members of the Corporation devote a large proportion of their time to the workings of this committee: these gentlemen are Mr. Henry Maclean, J.P., Chairman; Mr. Frederick Hamilton, T.C., Mr. John Byrne, T.C., and Mr. John Norwood, T.C. It is, perhaps, invidious to particularize, when all are deserving of praise; but I believe every member of the committee will agree with me that the labors of the gentlemen I have named in effecting sanitary reform in this city deserve special recognition.

The staff of the Public Health Committee consists of the Medical Officer of Health, the City Analyst, a Secretary—Mr. James Boyle, C.E., a most zealous and efficient officer—an Inspector of Nuisances, a Fever Inspector, a variable number of disinfectors, 8 Sanitary Sergeants of the Metropolitan Police (paid by the Corporation), and 3 Constables (who are not paid by the Corporation), employed in the detection of diseased and unsound meat and other provisions. To this list I should, perhaps, add one of the Lord Mayor's Deputy Clerks of the Markets, Mr. E. Webb, who acts under the committee, and affords assistance in the detection of diseased meat and of the adulteration of food. The efforts of this department of the Corporation are

unceasingly directed against everything that injuriously affects the public health, that the law permits them to deal with. The over-crowding of lodging-houses, the injurious emanations from factories of all kinds, and the sale of unsound and adulterated food have been greatly lessened by the vigorous action of this committee. They have caused the defective condition of the dairy-yards to be improved, and have banished innumerable pigs from the city precincts. They have compelled careless landlords to construct house drains, ash bins, and other necessary appliances, and to keep them in a cleanly state. Last year no fewer than 967 of these indispensable adjuncts to the dwellings of a civilised people were constructed, and 5,839 repaired or cleansed. 1,900 persons were convicted for breaches of various sanitary laws.

Some idea of the good accomplished by this committee may be formed from the fact that they caused to be remedied, in 1867, no fewer than 20,000 distinct nuisances. It can hardly be doubted but that the work performed by the Public Health Committee and the energetic Medical Officer of Health has lessened the mortality of this city, and diminished zymotic disease. Unfortunately, however, the registration of deaths, owing to its obvious inaccuracy, does not show that any sensible decrease in the death rate has taken place since the re-organisation of the sanitary department of the Corporation. 1,483 deaths from preventible diseases occurred in the year 1865; 2,309 in 1866; and 1,673 in 1867. The high mortality of 1866 was, however, due to Asiatic cholera: we must, therefore, compare 1867 with 1865. We find that last year the deaths from preventible causes were 383 in excess of those of 1865. Last year there was an epidemic of measles, which carried off nearly 400 persons within the city, or nearly three times as many as in 1865. There is little doubt, too, but the registration of deaths was far more imper-

fectly performed in 1865 than in 1867, which would cause an apparently greater mortality in the latter year. The registration of deaths in Dublin in 1864—the first year of the system—was proved from the number of interments in the city cemeteries to be exceedingly inaccurate; and it is unlikely that it was so much improved in 1865 as in 1867. Taking all these circumstances into account, I am quite satisfied that the deaths from diseases preventible by public hygiene have diminished during the last two years. As a proof of the improved sanitary condition of the city, I cannot do better than refer to the diminished number of deaths from, and cases of, fever—a disease which is generally the first to disappear under improved hygienic conditions. In 1865 the deaths from fever amounted to 492; in 1866, to 480; and in 1867, to 309. In the first four months of 1865 the admissions to the Dublin Fever Hospitals numbered 1,298; during the same period of 1866, 936; in 1867, 682; and in the first four months of the present year, only 591.

One of the most admirable, if not the most superior, of the sanitary organisations in Europe is, undoubtedly, the Irish Poor Law Medical Service. It consists of 4 Medical Inspectors, 788 Medical Officers, 39 Apothecaries, and 97 Midwives. By means of this organisation, medical relief is gratuitously afforded to the poorer classes of the community. There are 716 dispensary districts, and 1,042 dispensaries. The average population in each officer's district is over 7,000. Each dispensary physician receives on the average £87 a year, exclusive of fees for registration of deaths or for vaccination. In 1861 nearly 900,000 persons were attended by these medical officers; and it has been calculated by Dr. T. D. T. Maunsell that the average fee which the dispensary doctor receives for each attendance on a case is 5d. in rural districts and 1d. in towns! The expense of the whole Poor Law Medical Department is under £120,000 per annum.

The Irish dispensary physicians are a highly qualified body of practitioners. No person is eligible for the service unless he is more than 23 years of age, and is possessed of a medical, a surgical, and a midwifery diploma. That they perform their onerous duties efficiently is allowed on all sides. They have checked the spread of zymotic diseases; have literally "stamped out" small-pox; and have indirectly lessened pauperism, by diminishing sickness amongst the working classes. Wherever Asiastic cholera appears, or fever or other zymotic disease becomes prevalent, the authorities have in the dispensary doctors a highly educated, skilful, and experienced body of sanitarians ready, at a moment's notice, to grapple with the disease. Who can doubt but that the small number of deaths—3,400—from cholera and choleraic diarrhœa in Ireland during the last visitation of that disease was, in a great part, due to the unwearied exertions and professional skill of the Poor-law Medical Officers? In London alone more than that number perished in a fortnight.

As the Poor-law Commission are entrusted with the sanitary supervision of all the rural and many of the town districts, their medical officers are practically officers of health. They aid the Boards of Guardians in prosecutions for breaches of the sanitary laws; and in their capacity of registrars of deaths, they point out the causes of excessive mortality in their districts, with a view to their removal.

The Poor-law medical service is not a popular one. The officers have to perform hard and dangerous work, for which they are inadequately paid. It would be decidedly advantageous for the public weal were the dispensary doctors better paid. As medical practitioners, they, no doubt, perform the duties which devolve upon them as conscientiously as if their remuneration were tenfold greater than it is; but as officers of health, as professors of preventive medicine, their efforts would be powerfully stimulated by doubling their salaries.

The homes of the very poor are the native haunts of fever and similar diseases. From the mud cabin and the ricketty tenement in the crowded lodging-house the seeds of zymotic diseases spread broadcast over the land, finding a germinating place in the mansions of the rich as well as in the homes of the poor. It is clearly, then, the interest of all classes that the persons who have charge of the sick poor should be adequately remunerated, so as to make them feel contented with their position, and zealous in the discharge of their duties. The more efficiently the work of the dispensary doctors is performed, the less will zymotic diseases afflict all classes of society, and the smaller will be the burden upon those who support the pauper population.

At present the dispensary doctors are elected by the Local Boards of Poor-law Guardians. These bodies appoint in general very competent persons; but in some cases the high professional qualifications of one candidate are found to be outweighed, in the guardians' estimation, by the powerful political or "local" influence possessed by another and less competent person. I am quite sure that the Boards of Guardians do not place much value on this kind of patronage, and that they would not object to have their privilege of appointing medical officers transferred to the Poor-law Commission, or to some other impartial body. Why should not the competitive system of appointment be employed in the Poor-law Medical Service as it is in the Army and Navy Medical Services, and in the Civil Service? I would suggest that the Poor-law Medical Officers should be formed into a department of the Civil Service; that they should each receive a *minimum* salary of £100 per annum, to be increased £10 a year until it reached £200; and that they should receive a reasonable superannuation allowance, when ill health or old age had incapacitated them from properly performing their duties.

At present half the cost of the dispensary doctors is charged upon the Consolidated Fund and half upon the unions. The addition of a little more than ½d. in the pound increase in the poor rates would raise a fund sufficient to double the medical officers' salaries. It would be a fair division if the poor-law unions were charged with the increase in the salaries of the dispensary doctors and the Consolidated Fund with their retiring allowances. The Irish Medical Association has for the last two years urgently pleaded the cause of the Poor-law Medical Officers; and those who feel interested in this subject, and in that of the organisation of the body entrusted with the execution of the Medical Charities' Acts, will find them ably treated in the Journal of the Irish Medical Association and in Mr. R. F. Clokey's paper in the Dublin Quarterly Journal of Medical Science, May, 1867.

In concluding these Lectures on Public Health I would invite the attention of the authorities to the fact that no sanitarian occupies in this country a position similar to that so ably filled in England by Doctor Simon, the Medical Officer of the Privy Council. As Ireland has got a Privy Council, why should they not have a medical officer to advise them on all questions relating to the health of the public? I am aware that the Medical Inspectors of the Poor-law Commissioners are to some extent public sanitarians; but they have their time fully occupied in attending to their primary duties—namely, the inspection of the institutions under the control of the Commissioners. As for the local Medical Officers of Health, there are but three towns in Ireland—Dublin, Londonderry, and Sligo—provided with these important officers. Were the government to appoint a Medical Officer of Health for all Ireland, his duties might be made sufficiently numerous and important to more than justify the creation of a new office. The efforts of such an officer should be directed towards

the prevention of contagious, epidemic, and endemic diseases; he should advise as to the best means for suppressing the nuisances arising from certain manufactories and workshops, overcrowded burial grounds, marshes, and similar dangerous places; and he should sustain prosecutions against those who, by polluting air or water, violate any of the laws of the state. In such an officer the Privy Council would find a useful impartial assessor in any sanitary cases that might judicially come before them.